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USSR Report

MATERIALS SCIENCE AND METALLURGY

No. 68

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UDC 669.7:621.762

PROSPECTS OF ELECTROTHERMAL PRODUCTION OF ALUMINUM ALLOYS

Moscow TSVETNYYE METALLY in Russian No 1, 1980 pp 58-61

KALUZHSKIY, N.A., DOBATKIN, V.I., GOPIYENKO, V.G., LITVINTSEV, A.I., CHEREPANOV, V.P., KISELEV, V.P. and SHMAKOV, Yu.V.

[Abstract] Tests were conducted with a new design of aluminum alloy granulator with a capacity of up to 5,000 kg/hour for the purpose of demonstrating the economic feasibility of producing high-silicon aluminum alloys with new properties, for example high plasticity and mechanical strength, by the electrothermal process. This process imparts high strength and plasticity to Al-Si alloys with 17 and 25 percent silicon by virtue of rapid crystallization and refinement of the microstructure of the alloy. Tests conducted by Soviet machine-building and instrument engineering enterprises demonstrated the cost effectiveness of the process by way of example of the alloy AL-25, in which 400 kg of aluminum per ton of alloy are replaced with cheaper Al-Si primary alloy without a sacrifice of mechanical properties, and disclosed the promising prospects of high-silicon alloy processing by powder and granule metallurgy techniques. References 10: 8 Russian, 2 Western.
[93-7872]

UDC 669.715:621.74

EXPERIENCE IN THE PRODUCTION OF LARGE-INGOT ALUMINUM ALLOY CASTINGS FOR THE AUTOMOTIVE INDUSTRY

Moscow TSVETNYYE METALLY in Russian No 1, 1980 pp 94-96

KHOKHLEV, V.M., KUZNETSOV, B.L., STEPANOV, Yu.N., MAURITS, I.I. and MEDVEDEVA, L.N.

[Abstract] Two different large-ingot casting alloys were delivered by the Dnepr aluminum mill to the Volga and Kama automotive plants for testing to determine the advantages of using large-ingot aluminum alloy castings in the automotive industry. The alloys were AL4K, based on primary molten aluminum and crystalline silicon with up to 0.7 percent Fe. The alloys were smelted by two different processes, during which samples were taken to determine porosity and concentration of gases and iron impurities. The test disclosed that these alloys satisfy current requirements, and that the delivery of ingots weighing up to 600 kg offers economic and industrial advantages over the 15 kg ingots currently being delivered to the automotive industry for casting various truck parts. The total

annual saving for the national economy will be 1.3 million rubles. Large-ingot aluminum castings can satisfy the requirements of the automotive industry and other sectors of the national economy, but their adoption will be delayed by the lack of the necessary smelting facilities and by the failure of most industrial enterprises to accept large-ingot castings for remelting.
[93-7872]

UDC 629.735.33.015.43:539.219.2

CRACK DEVELOPMENT IN AIRTIGHT FUSELAGE PANELS UNDER SIMULTANEOUS CYCLE LOADS DUE TO SUPERCHARGE AND HIGH-FREQUENCY VIBRATION

Kiev PROBLEMY PROCHNOSTI in Russian No 1, Jan 80 pp 63-66 manuscript received 12 Dec 78

MOZZHEROVA, N. A., Central Institute of Aerohydrodynamics imeni N. Ye. Zhukovskiy, Zhukovskiy

[Abstract] An experimental study was made to determine the effect of high-frequency vibration due to pressure fluctuation in the air stream near propellers on the rate of cracking in the sheath of an airtight fuselage. Thin (860 x 1000 mm) cylindrical panels made of the D16AT aluminum alloy with a radius of curvature $r = 1750$ mm were tested, each panel consisting of two 1.5-mm-thick strips lap-joined and reinforced with two hoops and four stringers. These panels, mounted in a rigid steel fixture, were first subjected to excess pressure inside varying from 0 to 0.5 kgf/cm^2 at a frequency of 0.2 Hz with the hoop stress in the sheaths varying from 0 to 4.6 kgf/mm^2. In the second test series the panels were subjected to supercharge combined with high-frequency vibration for 21-min-long periods followed by pressure dropping between cycles. Experimental data on the distribution of static stresses along and normal to a crack, interpreted theoretically, indicate that vibration accelerates the cracking process. The general trend of the cracking process was found to be similar in both modes of loading, characterized by slow cracking up to a critical crack length within 90-100 mm and fast cracking beyond, also similar to its trend in the case of loading in uniaxial tension with simultaneous exposure to noise. For design purposes, in turn, theoretical relations are corrected here to agree with experimental data. Figures 5; references 8: 2 Russian, 6 Western.
[123-2415]

UDC 620.194

INVESTIGATION OF THE TENDENCY OF V93pch ALUMINUM ALLOY TOWARD CORROSION CRACKING IN A 3.5% NaCl SOLUTION

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 1, Jan-Feb 80 pp 28-31

BATRAKOV, V. P., ZHILIKOV, V. P., KAFEL'NIKOV, V. V. and KORNAUKHOV, B. Ye., All-Union Institute of Aviation Materials, Moscow

[Abstract] A double cantilever beam method was used to study corrosion cracking in V93pch aluminum alloy from which the coefficient of stress intensity K_I was determined. Two unspecified heat treatments were used: one to increase strength properties and the other to diminish corrosion cracking tendencies. The ratio of K_{Iscc} in lateral and longitudinal directions of crack movement was close to the ratio of K_I values, regardless of heat treatment, which led to the conclusion that the effect of a corrosive medium is the same in both directions. The difference in the paths and levels of K_{Ic} and K_{Iscc} for samples with a different direction of crack growth was explained by some anisotropy of alloy properties. Crack growth rate of V93pch, slow when K_I is close to K_{Iscc}, speeds up rapidly with increased K_I. Figures 3; references 6: 2 Russian, 4 Western.
[104-6368]

UDC 669.721:620.1

NONDESTRUCTIVE TESTING OF MECHANICAL PROPERTIES OF MAGNESIUM PLATES AND SHEETS

Moscow TSVETNYYE METALLY in Russian No 1, 1980 pp 96-97

DENISOV, S. S.

[Abstract] An experiment was conducted to determine the feasibility of testing hot rolled magnesium plates and annealed magnesium alloy sheets by the nondestructive eddy current testing technique, whereby electrical conductivity is measured with an induction tester without damaging the surface, and for which there is no need to prepare special test specimens. The technique is based on a correlation between mechanical properties and electrical conductivity. The nondestructive technique produces results just as good as destructive testing, will improve the reliability and productivity of testing and will produce a considerable annual saving.
[93-7872]

BERYLLIUM

UDC 539.219.3:546.82:546.45

BERYLLIUM DIFFUSION IN TITANIUM

Sverdlovsk FIZIKA METALLOV I METALLOVEDINIYE in Russian Vol 48, No 3, Sep 79 pp 663-665 manuscript received 26 Jun 78, after revision 19 Feb 79

SHABALIN, A. N., GLADKOV, V. P., GRUZIN, P. L. and SVETLOV, A. V., Moscow Engineering Physics Institute

[Abstract] The best dopant for preventing oxidation of titanium alloys is beryllium, which appreciably improves corrosion resistance even in concentrations as low as hundredths of a percent. The authors used the radioactive tracer method to study the diffusion of beryllium in cast alpha and beta titanium. The experiments were done on vacuum-melted VT-1 titanium with major impurities of 0.25 wt.% iron, 0.08 wt.% carbon, 0.012 wt.% hydrogen, 0.05 wt.% nitrogen and 0.15 wt.% oxygen. An aqueous solution of $BeCl_2$ tagged with the radioactive isotope ^7Be was applied to the carefully polished surface of the specimen. The treated surfaces of two specimens were placed in contact, the specimens were wrapped in beryllium foil and annealed in vacuum at about 400°C, after which the annealing chamber was filled with helium. It was found that the coefficient of volumetric diffusion of beryllium in alpha titanium at 990-1130 K is described by the formula

$$D = \left(14^{+31}_{-9}\right) \cdot 10^3 \exp\left(- \frac{62100 \pm 2400}{RT}\right).$$

Figures 2; references 10: 7 Russian, 3 Western.
[114-6610]

UDC 561.0.55

EFFECT OF TECHNOLOGICAL COATINGS ON THE STRENGTH OF TITANIUM ALLOY STAMPED PARTS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16 No 1, Jan-Feb 80 pp 106-107 manuscript received 21 Nov 77

KRIVENKO, M. P., ROKENENKOVA, V. A., SOLNTSEV, S. S., ARZHAKOV, V. M. and ZHUKOV, N. D., All-Union Institute of Aviation Materials, Moscow

[Abstract] VT5-1 and VT-9 titanium alloys coated with EVT-24 and EVT-24K coatings were fatigue tested after the dross-applied coatings were removed either by blasting with corundum or by etching. The fatigue strength of VT-9 with the EVT-24 was 40% higher than uncoated stampings while with the EVT-24K coating this value amounted to 60%. This was believed to be due to the brittle gas-saturated layer. Coating EVT24 does not have much effect on the fatigue of VT5-1 when that alloy is stamped in the alpha+beta region; however, samples made while in the beta-region were 1.7 times stronger with this coating. Both protective and lubricating properties were thought to give the improved fatigue strength when the samples were made in the alpha+beta region with only good protective properties generated by the beta-region. Removal of the gas-saturated layer was responsible for increasing the fatigue limit of VT-9 and VT5-1 coated with EVT-24. Figures 3; references 3: all Russian.
[104-6368]

UDC 669.018.95:669.295:546.281'261

THE INTERACTION KINETICS OF COMPONENTS IN A COMPOSITE MATERIAL CONTAINING A TITANIUM ALLOY AND SILICON CARBIDE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERILAOV in Russian No 1, 1980 pp 134-136 manuscript received 28 Apr 1977

SOKOLOVSKAYA, Ye. M., GUZEY, L. S., ZAYTSEV, B. G., CHUNIKHINA, L. L., and SHULEPOV, V. I., Moscow

[Abstract] The highly heat-resistant titanium alloys based on Ti-6.6Al-3.3Mo-1.8Zr-0.3Si were tested at temperatures above and below the heat at which the alloy phase emerges by hot pressing in an approximate 10^{-4} vacuum with a mixture of the granular alloy and fibers of silicon carbide of 100 mkm diameter. The samples obtained were then annealed in a vacuum. Measurements of the zones of interaction showed that time and temperature factors were involved, with temperature variations being of the greatest importance in the phase transformation in titanium alloys. Direct comparisons were impossible due to lack of primary data. References 9: 4 Russian, 5 English
[95-12131]

UDC 621.762

AN INVESTIGATION OF INTERACTION PROCESSES BETWEEN COMPONENTS OF A COMPOSITE OF THE VT-6 TITANIUM ALLOY AND AN ALLOY BASED ON ALUMINUM

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, 1980 pp 141-143 manuscript received 21 Apr 1979

VARENKOV, A. N., YEZHOV, A. A., KOSTIKOV, V. I., LEGKODUKH, A. M., MOZZHUKHIN, Ye. I., SHVARTS, V. I., and YAGUBCHIKOV, A. N., Moscow

[Abstract] Liquid AK4-1 aluminum alloy was poured onto the surface of VT-6 and EI-607 alloys that had been heated to the temperature of the aluminum alloy, in a $2 \cdot 10^{-5}$ vacuum for the VT-6 and with a flux layer at 750, 800 and 850° C for the EI-607. Isothermic contact in separate tests was maintained for 2, 5, 10 and 15 minutes with VT-6, and for 0.5, 3, 6, and 10 minutes for EI-607. The formation of a contact zone of complex structure and, after cooling, with a heterogeneous structure, was observed as a result of interaction. Both titanium and nickel were found to dissolve into the molten AK4-1 aluminum alloy, indicating the possibility of the formation of titanium and nickel aluminides. Increased time of isothermic contact brought increases in titanium and nickel content in the transition zone. Figures 2; references 4: all Russian.
[95-12131]

UDC 621.762.5:669.018.45:539.4

STRENGTH OF SINTERED Mo-Al_2O_3 AND Mo-ZrN COMPOSITES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1(205), Jan 80 pp 58-63
manuscript received 20 Apr 79

YEGOROV, F. F., KISLYY, P. S. and VERKHOVODOV, P. A., Institute of Problems of Material Science, Academy of Sciences UkrSSR, Institute of Superhard Materials, Academy of Sciences UkrSSR

[Abstract] An investigation was made of the effect of temperature, sintering time, porosity, grain size of the matrix and hardening phase on the strength of Mo-Al_2O_3(ZrN) cermets. The initial materials were 99.8% pure Mo, 99.72% pure Al_2O_3 and 98.1% pure ZrN. The average size of the molybdenum particles was 3-4 μm, and of the Al_2O_3 and ZrN particles 1 μm. Bending strength was determined by application of a concentrated force to specimens measuring 5 x 5 x 35 mm, and compressive strength was determined on cylindrical specimens 8 mm in diameter and 10 mm high. If was found that the strength of Mo-Al_2O_3 cermets with up to 30 vol.% oxide increases with simultaneous reduction in porosity up to a solid-phase sintering temperature of 1800° C. At higher sintering temperatures, strength decreases even though density continues to increase. The strength reduction was attributed to weakening of the bond on phase boundaries. Liquid-phase sintering reduces strength due to intensified interaction on the phase boundary with liberation of MoO, MoO_2 and MoO_3 vapors, forming macropores that generate cracks during fracture. Fracture was initiated by cracking of particles under the action of internal cleavage stresses. Strength was determined by size and shape of the hardening particles as well as by the properties of the matrix grains. Strength of adhesion was greater than cohesion in the Mo-ZrN system; the reverse was true for the Mo-Al_2O_3 system. Figures 5; references 10: 8 Russian, 2 Western.
[92-6610]

UDC 539.376:539.4

FEATURES OF LOW-TEMPERATURE CREEP OF LAMINAR COMPOSITES

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 48, No 3, Sep 79 pp 630-635 manuscript received 7 Feb 78, after revision 10 Oct 78

YAVOR, A. A. and CHEBOTAREV, V. A., Volgograd Pedagogical Institute imeni A. S. Serafimovich

[Abstract] An investigation was the behavior of laminar composites with a copper, brass and aluminum matrix and refractory Nimonic reinforcement under creep conditions at 400° C. The initial stress was 90% of the

macroyield point. An analysis was made of the changes in the effect structure of the matrix layers under prolonged loading at high temperature. It was found that the behavior of laminar composites under these conditions is determined by deformation interaction of the components through the boundary between layers and is independent of the nature of load distribution between matrix and reinforcement. At temperatures of 40% of the absolute melting point of the reinforcing material or lower, and stresses below 90% of the macroyield point, plastic deformation does not occur because there is no accumulation of damage in the matrix layers, which represent the weakest part of the composite. Figures 3; references 13: 12 Russian, 1 Western.
[114-6610]

UDC 678.067.5:677.4:539.377

STRESS RELAXATION IN CARBON FIBER AT ELEVATED TEMPERATURES

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 1, Jan-Feb 80 pp 3-9
manuscript received 13 Jul 79

MOSTOVOY, G. YE., RABOTNOV, YU. N., KOBETS, L. P. and FROLOV, V. I., All-Union Scientific Research Institute of Aviation Materials, Moscow

[Abstract] In a continuation of a study of stress relaxation in VMN-RK carbon fiber at 1200° C, the temperature range was extended upward and also the activation energy and the effective volume of relaxator elements characterizing the process kinetics were measured. All fiber specimens were 8.3 ± 0.16 μm in diameter and their average modulus of elasticity was 20,000 kgf/mm^2, with a 7.6% variance excluding the measurement error. They were either heated fast within 15-20 min or heat treated before relaxation for 1 hr and then thermomechanically treated during relaxation. This treatment was found to increase the thermal modulus of elasticity, but only at temperatures above 1500° C. The relaxation curves, measured at temperatures from 1200 to 2000° C, follow the trend typical of metals and polymers. The relaxation of tensile and compressive stresses proceeds similarly, the process being almost completed after 20-30 min. An analysis of the results based on the fibrilar model, indicates two relaxation mechanisms. Carbon fiber behaves below 1600° C like a brittle material with linear elastic characteristics and reversible changes in mechanical properties, it undergoes fast spontaneous graphitization with irreversible changes in properties within the 1600-1700° C range, till above 1700° C the mobility of even small clusters of atoms in the graphite-like layer of a much denser fiber material becomes high and relaxation occurs through slippage of this layer. Figures 5; references 7: 5 Russian, 2 Western.
[120-2415]

CORROSION

UDC 620.193.01:669.245:546.77

INVESTIGATION OF THE MECHANISM OF CORROSION STABILITY IN NICKEL-MOLYBDENUM ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 1, Jan-Feb 80 pp 7-13 manuscript received 26 Oct 79

KOLOTYRKIN, YA. M., KNYAZHEVA, V. M., TSENTA, T. YE., KOZHEV-NIKOV, V. B., ZAKHAR'IN, D. S. and SVISTUNOVA, T. V., Scientific-Research Physico-Chemical Institute imeni L. Ya Karpov, Moscow

[Abstract] The behavior of nickel, molybdenum and alloys of these metals was studied where Mo content ranged from 2 to 30 mass %. To provide uniform grain size, the samples of Ni-30Mo were heated at 1200° C, Ni-20Mo at 1150° C and Ni-10Mo and Ni-5Mo at 1100° C and water quenched. These samples were then corroded in solutions of 1N HCl and 1N H_2SO_4 at 50° C. The principles of partial processes in the dissolving of the components in N-Mo alloys and surface composition changes as a result of corrosion were investigated using electrochemical and gamma-spectrometry as well as photoelectronic spectroscopy. The existence of two basic regions of potentials was established which had the greatest significance for industrial use of these alloys. Considerations were expressed about the probable mechanism of alloy corrosion stability according to which the high retarding action of Mo and investigated inhibitors (J^- ions, propynol) was caused by blocking active centers of the dissolving surface. Along with this, at adequate negative potentials, an additional retarding effect from the forming passive film, enriched with molybdenum oxides, was possible. Figures 4; references 16: 14 Russian, 2 Western.
[104-6368]

KRIVBASS IRON ORE PRODUCTION

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 61, 13 Mar 80, p 1

[Article by L. Timirgaleyeva: "Records are Born Here"]

[Text] Krivbass now produces almost one half of the All-Union iron ore output. In its reserves and quality the basin is unique and is one of the most prominent in the world. But it began as a small pit, which has been transformed into a huge mining enterprise bearing the name of Feliks Dzerzhinskiy. Three of its shafts -- "Kommunar," "Saksagan'," "Gigant-glubokaya," and the "Severnyy" open pit -- yield about 8 million tons of metallurgical raw material.

The friendly Dzerzhinskiy collective has kept up a tradition for many years now -- completing the yearly plan on time and producing more ore than the plan called for. The miners did not change this in the current five-year plan. They have been the winners in the All-Union and republic competition among mining enterprises 14 times in a row.

The mine workers remember well the day when they received congratulations from the General Secretary of the CPSU Central Committee, President of the Presidium of the USSR Supreme Soviet L. I. Brezhnev on the occasion of their production of 1 million tons of iron ore above and beyond the plan.

The title of "Enterprise with a high level of production and good working conditions" has been awarded to the mine management many years in a row.

And now there is another achievement: a collective of the Order of the Red Banner of Labor of the mine management imeni F. Dzerzhinskiy has been recognized as the winner in socialist competition for 1979 and has been awarded the challenge Red Banner of the CPSU Central Committee, the USSR Council of Ministers, the VTsSPS [All-Union Central Trade-Union Council] and the VLKSM [All-Union Lenin Young Communist League]. The miners produced 54,800 tons of iron ore above the plan, overfulfilled the plan for realization of output, and increased labor productivity by 1.9 percent more than the plan called for. In the same year, in the beginning of November, they completed their socialist obligations for the current five-year plan.

The minedrilling brigade of the UkrSSR State Prize winner, honored miner of the republic Anatoliy Grigor'yevich Tret'yak, was one of the first brigades in the Krivbass to complete its five-year plan, in the "Gigantglubokaya" shaft. Having mastered the method of the brigade contract, the miners make every minute of work time count, use electric power wisely, and make optimum use of drilling mechanisms and tunneling complexes. By these actions the brigade saved about 2,000 rubles, and the cost of digging out one meter of underground workings was reduced by 0.7 percent.

Use of the brigade contract in underground extraction has been widely adopted in shafts of the mine management. The originators of this method now have a lot of followers. Now everyone here is proud of the successes of the best collectives, which are headed by the brigade foremen V. Likholit, N. Popov, V. Zamriy, B. Petukhov, Ye. Sorin and others.

In one year the Dzerzhinsky mine workers will observe the 100th anniversary of their enterprise, which is justifiably considered the standard bearer of Krivbass mining. The miners are now participating in the second birth of their minepit. Leading specialists of the enterprise, together with scientists of scientific research and planning institutes of the country, have opened up a development add enrichment of magnetite quartzites for the first time in Krivoy Rog, which until now have not been used. A concentrate of these quartzites, containing 67 percent iron, is already being produced on the redesigned first line of the enrichment plant. This is only the beginning. There are plans to expand the development and enrichment of the magnetite quartzites and to finish construction of the second line of the enrichment plant in order that, by using the voluminous capacity of the "Kommunar" shaft, the production of metallurgical raw material can be increased.

Socialist competition is being extended to all shafts of the mine management in preparation for the 110th anniversary of V. I. Lenin's birth. The miners have set themselves the goal of producing 15,000 tons of iron ore in excess of the plan by the jubilee of the leader, which is one half of the annual obligation.
[118-9424]

9424
CSO: 1842

UKRAINIAN FERROUS METALLURGY QUOTA FAILURES NOTED BY MINISTRY BOARD

Kiev PRAVDA UKRAINY in Russian No 14, 18 Jan 80 p 3

[Article: "Better Utilization of Metallurgy's Potential"]

[Text] Quotas relating to execution of the decisions of the November 1979 Plenum of the CPSU Central Committee and the directives and aims described in the address presented at it by General Secretary of the CPSU Central Committee, President of the Presidium of the USSR Supreme Soviet, Comrade L.I. Brezhnev, and the decrees of the December 1979 Plenum of the Central Committee of the Communist Party of the Ukraine were discussed at an extended meeting of the board of the republic's Ministry of Ferrous Metallurgy held in Dnepropetrovsk. Invited to the meeting were managers, secretaries of party committees, chairmen of trade union plant committees of enterprises and associations, personnel of the ministry and republic committee of the industry's trade union, and secretaries of a number of party obkoms in charge of problems relating to the industry.

The reader of the report--Minister Ya.P. Kulikov--and L.D. Yupko, the director of the Zaporozhstal' Plant, and A.A. Shvedchenko, the director of the Novomoskovsk Pipe Plant, Party Committee Secretary of the Zhdanovsk Azovstal' Plant Ye.I. Eskin and other speakers noted that at enterprises of the republic's ferrous metallurgy industry since the beginning of the five-year plan period definite work has been done on the re-equipment of production, dozens of powerful units have been put into service, and a number of metallurgical processes have been improved with the assistance of scientists. Rightfully regarded as right-wingers of the fourth year of the five-year plan period are the teams of the Donetsk imeni V.I. Lenin and Dnepropetrovsk imeni Petrovskiy metallurgical plants, the Nikopol', Novomoskovsk and Nizhnedneprovsk pipe plants, the Krivbassruda Production Association and the Yuzhnyy and Marganets ore concentration combines.

However, on the whole the industry did not cope with the plan quotas of the past year for the production of the most important kinds of products and technical and economic indicators worsened as compared with 1978. Subjected at the board's meeting to harsh criticism for the nonfulfillment of State quotas and unsatisfactory management of production were the directors of the Krivorozhstal', Dneprovskiy imeni Dzerzhinskiy, Makeyevka, and the Kommunarsk metallurgical plants, the Avdeyevka, Zaporozh'ye and Zhdanovsk coking byproduct combines and the Dneprovskiy, Tsentral'nyy and Ingulets ore concentration combines.

Having made a profound analysis of the shortcomings, the meeting's participants pointed out ways for eliminating them and measures for improving the efficiency and quality of work in the concluding year of the five-year plan period. The entire increase in the production of cast iron--2.7 million tons, of steel--2.6 million tons, and of rolled metal--2.4 million tons, must be gained on account of the better utilization of existing plants. Measures have been provided for the intensification of technological processes, reducing the idle time of plants, improving the quality of products, and improving the planning and organization of production and the management of enterprises.

Great attention was paid to questions relating to strengthening the raw materials base and to the timely entry into service of projects for the recovery of iron and manganese ore and for the production of concentrate, pellets and coke. Plans have been made to expand the production of effective kinds of rolled metal which make possible a savings of metal in the national economy. The necessity was emphasized of closing all channels for the above-plan consumption of raw material and physical and fuel and energy resources, of strengthening production and labor discipline in every possible way, of strengthening the effectiveness of competition, and of supporting in a businesslike manner the creative initiative of workers and specialists.

Speaking at the extended meeting of the board were Politburo Member and Secretary of the Central Committee of the Communist Party of the Ukraine A.A. Titarenko and USSR First Deputy Minister of Ferrous Metallurgy D.P. Galkin. Ye.V. Kachalovskiy, first secretary of the Dnepropetrovsk Party Obkom, participated in the board's work.
[117-8831]

8831
CSO: 1842

UDC 621.3.038.8:621.78.001

FEASIBILITY STUDY OF TEMPERING WITH A CW GAS LASER

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 1, 1980 pp 24-26

KOTSYUBINSKIY, O. YU., Experimental Scientific Research Institute of Metal-Cutting Machine Tools

[Abstract] The author calculates gas laser irradiation parameters that maximize the casehardening layer without melting the surface of the item being treated. The analysis is based on satisfaction of three conditions: 1) heating the metal to the temperature required for tempering with consideration of the high speed of the process; 2) additional heating to a temperature no higher than the melting point of the given material; 3) as all sections of the tempered layer are cooled to the martensite transformation temperature, cooling to any intermediate temperature must not cause premature breakdown of austenite. The proposed engineering method for calculating the thickness of the casehardened layer from laser parameters includes formulas for the specific heat flux and the specific power of the heat flux absorbed by the surface, the lasing time that ensures the necessary duration of cooling to a given temperature, the true cooling rate of the casehardened layer at this temperature, the rate of displacement of the laser beam over the surface, and the thickness of the casehardened layer. An example shows that the proposed technique is technologically feasible. Figures 2; references 3: all Russian.
[115-6610]

UDC 539.385:620.193.2:669.721.5

SOFTENING OF THE IMV6 MAGNESIUM ALLOY DUE TO FATIGUE

Kiev PROBLEMY PROCHNOSTI in Russian No 1, Jan 80 pp 35-39 manuscript received 5 Oct 78

GRINBERG, N. M. and SERDYUK, V. A., Physico-Technical Institute, Academy of Sciences of the Ukrainian SSR, Kharokov

[Abstract] A study was made of structural changes in the hot pressed IMV6 magnesium alloy (7.8% Y, 0.55% Mn, 0.49% Cd, 0.12% Al, 0.11% Ce) due to fatigue. Specimens of this alloy punched from strip and then polished, mechanically as well as electrolytically, were mounted in cantilever fashion and cyclically loaded in symmetric flexure with a constant strain amplitude = 0.0034 in air and in vacuum at room temperature and at 153° K. Microhardness measurements revealed a softening due to fatigue at room temperature in air, predominantly within the surface layer, which was also indicated by a decrease in the load amplitude after an increasing number of cycles. No softening was found to occur at low temperature. The life of specimens was greatly prolonged, fourfold to sixfold, in vacuum. According to the results of examination under an optical microscope, crack initiation is inhibited much longer at a low temperature and in vacuum both crack initiation and crack propagation proceed at much slower rates than in air. Figures 5; references 23: 13 Russian, 10 Western.
[123-2415]

UDC 539.385:669.721.5

EFFECT OF LOW TEMPERATURE ON THE KINETICS OF FATIGUE FAILURE IN MAGNESIUM ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 1, Fan-Feb 80 pp 73-76 manuscript received 25 Jan 79

SERDYUK, V. A., GRINBERG, N. M., MALINKINA, T. I. and KAMYSHKOV, A. S., Physico-Technical Institute of Low Temperatures, Academy of Sciences UkrSSR, Khar'kov

[Abstract] MA2-1, MA15, IMV6, MA21 and MA12 magnesium alloys were investigated to determine the degree of damage in the different stages of the fatigue process and to explain the effect of low temperature on the length of the individual stages. All the alloys except MA21 had an alpha-solid solution phase composition (magnesium-base HCP lattice) while MA21 had the alpha-phase plus the beta-phase with a lithium-base BCC lattice. Alloy samples were put under a cyclic symmetric and constant load at a frequency of 25 Hz which was 0.6 of their yield point at room temperature. Testing was done in a vacuum of 0.13 mPa at 20° and -120° C.

Results showed that the alloys could be divided into two groups according to their behavior at low temperature. The first group (MA15 and MA12) had increased durability at low temperature due to a longer stage of crack nucleation. The rate of crack growth, emerging beyond the grain limits, was faster at low temperature than at room temperature. Alloys of the second group had both an extended stage of crack nucleation and slowed growth rate at reduced temperatures. Alloys in the first group underwent brittle fracture while the others had a ductile micromechanism of fracture. These alloys of the second group had either a two-phase structure (MA21) or a metastable one which changed as a result of strain aging (IMV6). Apparently, the structural state manifests a varying degree of plastic deformation development in the process of fatigue from which, in turn, depends the rate and micromechanism of crack growth. Figures 3; references 4: all Russian.
[104-6368]

UDC 539.43:669.721.5:620.19

DEVELOPMENT OF FATIGUE CRACKS IN MA2-1 MAGNESIUM ALLOY SHEETS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 16, No 1, Jan-Feb 80 pp 64-69 manuscript received 16 Dec 78

YAREMA, S. YA., OSTASH, O. P., ZINYUK, O. D. and VASHCHENKO, A. N., Physico-Mechanical Institute, Academy of Sciences UkrSSR, L'vov

[Abstract] The principles involved in development of fatigue cracks were investigated for MA2-1 magnesium alloy where the load amplitude varied from threshold to critical. A total diagram of the fatigue failure in the alloy is presented and the characteristics of its cyclic cracking stability are determined. An anomalous phenomenon of crack growth rate jump was observed in the interval of K_{max} from 5.2 to 4.5 $MPa \cdot m^{1/2}$. The possible causes for this phenomenon were felt to be the intergranular slip at that point in the cyclic duration. It is shown that, according to the characteristics of cyclic crack stability, related to specific weight, MA2-1 alloy exceeds V95AT1 alloy in the region of slow and fast crack growth rates and surpasses D16At alloy only in the region of average crack growth rates. Figures 5; references 14: 7 Russian, 7 Western.
[104-6368]

ACADEMICIAN MEL'NIKOV DISCUSSES MINERAL RESOURCES OF THE USSR

Moscow TRUD in Russian No 73, 28 Mar 80 p 2

[Article by Academician N. Mel'nikov, member of the Presidium of the USSR Academy of Sciences, Hero of Socialist Labor: "Conserve Mineral Resources"]

[Text] Mineral raw materials are a key item in the national economy. There are more than 20,000 proven mineral deposits in this country. The Soviet Union accounts for 28% of world mining output, while the U.S. share is 23-24%. If we bear in mind that Russia produced 20 times less volume of minerals than the United States, 10 times less than Great Britain, and five times less than Germany, our practical achievements will fall into perspective.

An extremely important advantage of the Soviet Union is that it can meet its own mineral resource needs. We must bear in mind, however, that development of a country's mineral raw materials base is achieved at the cost of enormous labor. Up to 40% of capital investment in industry is spent on exploration for and mining of minerals. Concentrated in these activities are 30% of the nation's productive resources and 18% of its labor resources.

Today even this is proving insufficient. Growing and developing industry -- and this is natural -- is demanding more and more mineral raw materials each year. This means that it is necessary to engage in additional expenditures on looking for and surveying new mineral deposits and construction of mining enterprises. And yet right now we could be producing 25-30% greater output at existing mines, plants and mills. And this additional output would cost the economy 50 to 75% less than utilization of specially-mined minerals.

How can this be achieved? There is only one way: by comprehensive utilization of ore bodies, fuller extraction of ore constituents during processing, for every mineral deposit is by its very nature an aggregate of one or several principal minerals and a number of secondary minerals.

What is required to achieve this? First of all development of new processes and their bold practical adoption. I shall cite several examples. In this country we have long been employing the geotechnological method of mining sulfur. It is melted with hot water and drawn to the surface in melted form. This makes the mining operation easier and also cheaper and, of equal importance, helps increase labor productivity.

But the geotechnological method -- subsurface leaching, as it is called -- can also be employed for efficiently working reserves of other low-grade ores as well, where mining with other techniques is sometimes uneconomical. This method makes it possible to extract secondary constituents from mineral ores, metals left behind in mine and beneficiation mill tailings. We know that in a number of countries 20% of copper production is obtained by leaching. In this country adoption of this advanced technique is being delayed due to a lack of inexpensive reagents and special -- but generally not highly complex -- equipment.

The USSR Ministry of Nonferrous Metallurgy is also ignoring another promising method -- separate working of ores of different types. At the present time they are mined together, which makes subsequent processing very complicated, and frequently leads to a situation where certain constituents simply end up in the tailings. The separate processing technology employed in this country is imperfect and costly, and therefore is utilized to a very small degree only at the Almalyk Mining and Metallurgical Combine and at the Noril'sk Combine. Industry needs new, efficient solutions, which would make it possible more extensively to adopt separate processing in a practical manner.

Mined mineral raw materials are subjected to primary processing -- concentration or beneficiation. Today the most accessible mineral deposits, which are close to the surface, have become exhausted. The geologic conditions in which ores are mined have become more complex. The grade of the ore has also correspondingly declined. Therefore only improvement in beneficiation processes and conditions can increase recovery of valuable metals. We have had some success in this area. At the present time 7% more copper is being recovered from complex ores than in the recent past. The lead content of mined ores has declined by 0.2% in recent years. In spite of this, however, recovery of lead into concentrate has increased from 79.4 to 81.2% due to process improvement.

These examples, however, gratifying as they may be, cannot leave us entirely satisfied. Losses during primary processing are still fairly high. Recovery of a number of valuable metals during beneficiation sometimes does not exceed 60%. The situation is particularly unfavorable in the case of tin, nickel, and molybdenum. In nonferrous metallurgy there is considerable reserve potential for additional utilization both of primary and secondary constituents.

Calculations indicate that extensive adoption of combined technologies in processing Ural pyrite copper ores would make it possible to increase zinc production by 15%, copper production by 5-10%, sulfur production by 18%, and production of rare elements by a whopping 50%. Combined processing of complex ores makes it possible to recover copper, lead, zinc, tungsten, and indium from these ores, in addition to tin. At the present time these elements, the total value of which is as much as 40% of the value of the recovered tin, is essentially lost.

The enterprises of the USSR Ministry of Ferrous Metallurgy also possess considerable potential for fuller utilization of ores. At the ferrous metallurgy mills and mines of Kazakhstan, for example, up to the present time they have been recovering only iron from the mined ore. The magnetite ores processed at the Sokolovsko-Sarbayskiy Mining and Beneficiation Combine contain 25 accessory constituents. The majority of these are simply relegated to the slag heap. Ore mined from the Lisakovsk ore body is a valuable complex raw material. In addition to iron, it contains aluminum, phosphorus, and vanadium. Only the iron is utilized, however, that is, 68% of the potential value of this ore.

We possess vast reserves of oxidized and mixed iron ores. The slag heaps of the Krivoy Rog Basin alone contain more than 300 million tons of ore with 38-45% iron content and approximately 500 million tons of oxidized quartzites. Millions of tons have also piled up in the area of the Kursk Magnetic Anomaly. Oxidized ores do not possess magnetic properties and therefore require a totally different beneficiation process. Research in this area has dragged on for years. The USSR Ministry of Ferrous Metallurgy is failing to display adequate concern about utilization of this valuable mineral raw material.

Recently there has been increased use of coal as a power-generating fuel. In connection with this there arises the problem of removing sulfur from coal, with sulfur a valuable chemical raw material in its own right. At the present time only one half of 1% of the sulfur contained in coal is trapped during combustion. Several years ago one fourth of the coking coal produced in the Pechora Basin was being burned as ordinary power-generating fuel. Such profligacy is totally unwarranted!

Our discussion on comprehensive utilization of raw materials would be incomplete if we did not mention the problem of recovery of waste materials. Each year mining enterprises pile up approximately 5 billion tons of overburden, while beneficiation plants relegate 700 million tons to the slag heap. These waste materials occupy more than 1 million hectares of fertile land, which of itself does enormous detriment to agriculture.

But the by-products of beneficiation plants, metallurgical plants, and thermal electric power stations contain highly valuable mineral raw materials, from which right now or in the very near future we could obtain meaningful products. In many cases it also proves feasible to recover ferrous, nonferrous, and even precious metals from coal waste products. It is a known fact, for example, that the slag discarded at some mining-industry plants in Eastern Kazakhstan contains two to three times the quantity of metals as in some ores.

How are these riches being utilized? Unfortunately, quite unsatisfactorily at the present time. In spite of the fact that the "Fundamentals of

Legislation of the USSR and the Union Republics on Mineral Resources" clearly formulate the requirement of efficient and comprehensive utilization of raw materials, up to the present time even in such well-developed mining-industry regions as the Urals and Northern Caucasus, only 10-13% of waste products are recovered.

Possibilities for their utilization are essentially unlimited. In the Angren coal field rock containing large quantities of quartz sand, limestone, refractory clay and kaolin is going into the spoil banks. And yet this rock could be used to produce glass, silicate brick, lime, porcelain, and earthenware. At the Kachkanar Mining and Beneficiation Combine, 25 million tons of rock is piled into spoil banks each year in the process of mining iron ore. Large quantities of crushed rock could be produced from this waste. In the Nikopol' Manganese Ore Basin more than 130 million cubic meters of rock is amassed each year, containing large quantities of ceramic and keramzit clays, quartz sand and construction limestone.

Some people are of the opinion that utilization of waste products is an unprofitable undertaking, since it requires construction of new and renovation of existing mining-beneficiation enterprises and the establishment of additional facilities, that is, considerable capital expenditures in the final analysis. But we should bear in mind that the cost of maintaining dumping and storage areas in the mining industry is also not cheap. At some enterprises outlays on establishing dumping and storage areas comprises up to 10% of total outlays on construction. In addition we should not forget about the land which, if the waste were utilized, we could return to agricultural use. And finally, we should also bear in mind that the earth's resources, although considerable, are not inexhaustible. Therefore, in spite of costs, we believe that utilization of waste materials is economically expedient.

In conclusion we should like to present a proposal. We believe that it would be beneficial to establish a number of special production-industrial associations, based on large mineral deposits, with a complete cycle of comprehensive processing of raw materials. These associations could become experimental testing grounds for developing the most efficient techniques of utilization of commercial minerals, adopting waste-free processing, which could subsequently be adopted at other enterprises as well.

Our nation possesses vast mineral resources. Mineral reserves comprise our greatest national wealth. But precisely this fact obliges us to manage these resources in a thrifty and economical mannner.
[122-3024]

3024
CSO: 1842

UDC 546:669.295.24

SELF-PROPAGATION HIGH-TEMPERATURE SYNTHESIS OF TITANIUM NICKELIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1(205), Jan 80 pp 7-11
manuscript received 14 Sep 78

BRATCHIKOV, A. D., MERZHANOV, A. G., ITIN, V. I., KHACHIN, V. N., DUDAREV, YE. F., GYUNTER, V. E., MASLOV, V. M. and CHERNOV, D. B., Siberian Physicotechnical Institute, Division of the Institute of Chemical Physics, Academy of Sciences USSR

[Abstract] Traditional methods of producing marmem alloys of the Nitinol type by melting or powder metallurgy do not always give adequate homogeneity for realizing shape-memory properties. It is shown that the degree of homogeneity can be enhanced by doing the first stage of synthesis in a combustion wave or high-temperature self-propagation process. Alloys based on titanium nickelide are produced by this method to determine the optimum parameters of the technique. An investigation was made of the effect of various parameters on the burning rate and the phase composition of the final product. The results showed that the high-temperature self-propagation method of synthesis is more effective than conventional procedures for making shape-memory alloys of this type. Figures 5; references 10: all Russian.
[92-6610]

UDC 621.762.274:621.357.12

ELECTROCRYSTALLIZATION OF IRON SINGLE-CRYSTAL WHISKERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1(205), Jan 80 pp 1-6
manuscript received 16 May 79

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[Abstract] Ultrafine metal powders with dendritic particles can be produced by electrolysis in a two-layer bath on a rotating cathode at fairly high rates of cathode rotation and low concentrations of oleic acid in the upper layer. Single-crystal whiskers are produced in such a bath at low rates of cathode revolution with high concentrations of oleic acid in the upper layer. The author describes the use of such a process for making iron whiskers on a disk cathode with a diameter of 50 mm, turning at a speed of 2 rpm in a two-layer bath with a current density of 15 mA/cm^2. The upper layer was a 10% solution of $FeCl_2$ (15 grams per liter). The technique can also be used to produce ultrafine powders of copper, silver, cobalt and other metals and alloys. Depending on the conditions of electrocrystallization, the dimensions of the

crystals range from 0.02 μm to a few μm in thickness, and from 0.1 μm to a few tens of μm in length. At very low velocities of rotation, the film on the cathode becomes so thick that the organic layer is not adequate for passivating the lateral surfaces of the whiskers. The author calculates film thickness as a function of depth of immersion, rate of rotation, viscosity and density of solutions. Figures 4; references 4: all Russian.
[92-6610]

UDC 621.762

FRICTION AND WEAR OF A MOLYBDENUM-BORON CARBONITRIDE PAIR AT HIGH TEMPERATURES IN VACUUM

Kiev POROSHKOVAYA METALLURGIYA in Russian No 1(205), Jan 80 pp 89-91
manuscript received 12 Apr 79

GURVICH, O. S., DUBOVIK, T. V. and STRUK, L. I., All-Union Scientific Research Institute of Electrothermal Equipment, Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] Results are given of tests of friction couples made up of a molybdenum disk rotating against a carbonitride sleeve under a load of 3.3 kgf/cm^2 at a velocity of 0.057 cm/sec in vacuum. The coefficient of friction was determined at 20, 300, 700, 1000, 1300 and 1500° C. As the heat was increased from room temperature to 300° C, the coefficient of friction increased sharply to 0.55, and then fell gradually, reaching a value of 0.2 at 1000° C, which is close to the coefficient of friction of boron nitride on graphite. Wear determined by the weight loss method after rotation for 6.5 hours at 700 and 1300° C was within the limits of measurement of the balance (±0.01 g). The results of tests at 1500° C showed that these friction couples are suitable for applications in electric vacuum furnaces. Figures 2; references 10: all Russian.
[92-6610]

UDC 621.763:621.396:669.5'71'72

INVESTIGATION OF THE PROCESS OF FAILURE IN REINFORCED MAGNESIUM- AND ALUMINUM-BASE COMPOSITES BY THE METHOD OF SOLUTION ELECTRON MICROSCOPY

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 80 pp 87-90 manuscript submitted 28 May 79

KARPINOS, D. M., KADYROV, V. KH., GORDIYENKO, A. I., MOROZ, V. P. and VERKHOVODOV, P. A., Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] Composites were produced to form a ductile matrix-ductile fiber product using Mg and Al as the matrices and fibers of Kh14N14M2 steel and boron. Fractographic analysis showed that a ductile matrix-ductile fiber composite (Mg-steel, Al-steel) undergoes ductile failure in the matrix without any changes in the structural morphology of the fracture. Destruction of the fibers is accompanied by necking where with a test temperature increase the processes of plastic flow in the fibers are intensified, which makes it possible to consider the fiber role as a determining factor in the fracture of the entire material. In a composite with a plastic matrix-brittle fiber (Mg-B, Al-B), the matrix fails in a ductile mode while the fibers are brittle. Increasing the test temperauure amplifies the deformation processes of the matrix, subsequently the fibers are crushed and the strength properties of the whole material are lowered. Figures 5; references 6: 3 Russian, 3 Western. [98-6368]

UDC 621.762

HIGH-TEMPERATURE MATERIALS AND COATINGS BASED ON INTERMETALLIDES OF THE NICKEL-ALUMINUM SYSTEM

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 80 pp 33-39 manuscript received 5 Jul 79

PORTNOY, K. I., BUNTUSHKIN, V. P., ZAKHAROV, B. M. and SHAPYROV, A. E., All-Union Scientific-Research Institute of Aviation Materials

[Abstract] Certain physical, mechanical and technological properties are described for powders and cast compositions made from Ni-Al metallides along with the properties of coatings made from high-temperature nickel alloys. Tensile strength of the metallides was lower for the powdered material than the cast counterpart while just the opposite was true for elongation and impact strength. Thermal conductivity and coefficient of thermal expansion was higher for the metallides than for

the corresponding nickel alloy. When compared to WC, Ni_3Al (alloyed) was less wear resistant in the plasma coated form. Results of these tests prompted the conclusion that these materials are well suited for use at high temperatures and in corrosive solutions. Figures 5; references 6: 2 Russian, 4 Western.
[98-6368]

UDC 621.762.4:539.4:536.6.636.2

EFFECT OF ZIRCONIUM CARBIDE AND CARBON ADDITIVES ON THE PHYSICAL AND MECHANICAL PROPERTIES OF ZIRCONIUM DIBORIDE

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 80 pp 27-29 manuscript received 8 Aug 79

ANDRIYEVSKIY, R. A., KOROLEV, L. A., KLIMENKO, V. V., LANIN, A. G., SPIVAK, I. I. and TAUBIN, I. L., Moscow-Podol'sk

[Abstract] The properties of ZrB_2-ZrC and ZrB_2-C two-phase composites were studied with samples produced by hot compacting of powders. At 2200-2300° C active compaction was observed in the first 20-30 minutes under a pressure of 300-400 kgf/cm^2. The addition of either ZrC or C had little effect on the relative density of the composites although addition of graphite caused a small degree of shrinking which was not surprising since the relative density of the compacted samples was almost 95% without the additives. Addition of ZrC to ZrB_2 did not significantly affect strength. The thermal conductivity of ZrB_2 was lowered when the additives were introduced to form composites. Figures 1; references 9: 7 Russian, 2 Western.
[98-6368]

UDC 621.762

INVESTIGATION OF THE FEATURES OF THE PROCESS OF PRODUCING EXTRUDED NICKEL FIBERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 80 pp 1-4 manuscript received 13 Mar 79

FEDORCHENKO, I. M., KOSTORNOV, A. G., KIRICHENKO, O. V., CHERNYSHEV, L. I. and PEREPELKIN, A. V., Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] Grade OP4 carbonyl nickel powders and viscose were used as the initial materials for investigating the process of producing extruded nickel fibers of such small dimension as to be in the whisker class.

After extrusion, the treating process consisted of heating in hydrogen in the interval 20-1400° C for one hour and measuring the mass decrease and volume changes. Mass lost was noted for almost all temperatures, being quite small above 400° C. Loss of binder started at 800° C and the process was completed at 1200° C. The amount of residual carbon in fibers sintered at 1200° C was 0.02-0.03 mass %. Loss of the cellulose binder resulted in shrinkage of the fibers to form an almost nonporous fiber. Figures 5; references 6: all Russian.
[98-6368]

UDC 621.724

LOCATING SECTIONS OF PHYSICAL CONTACT BETWEEN DETONATION COATINGS AND BACKINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3(207), Mar 80 pp 27-29 manuscript received 18 Oct 79

KLIMENKO, V. S., SKADIN, V. G. and ALIFANOV, YU. P., Kiev

[Abstract] A technique is proposed for diffusion annealing of sputtered coatings of nickel on an aluminum substrate to determine the compactness of the zone of contact between coatings and backing. These materials were chosen because of their high interaction activity, which according to preliminary data should lead to intensive formation of solid solutions or chemical compounds as a result of detonation sputtering. Nickel-coated aluminum specimens were annealed at 450-500° C for 5 hours. Examination of the annealed specimens showed diffusion of aluminum into nickel. When the temperature of the coating powder was reduced by diluting the explosive charge with nitrogen, the diffusion coating was irregular in thickness and showed breaks. Increasing the temperature of the coating powder increased the area of physical contact, as shown by the uniformity of the diffusion layer after annealing. The thickness of the diffusion layer, which is apparently the intermetallic compound Ni_2Al_3, was 15 μm, and microhardness varied from 440 to 480 kgf/mm^2 with a load of 10 g on the indentor. The microhardness of the aluminum backing was no greater than 75 kgf/mm^2, and that of the nickel coating did not exceed 150 kgf/mm^2. The differences were still greater for nickel coatings on St.3 steel. In one case a transition layer was formed, and in the other case traces of visible diffusion were observed on the coating-backing interface only at isolated spots. Figures 1; references 6: all Russian.
[121-6610]

UDC 621.762:669.018

INVESTIGATION OF THE PROCESS OF NITRIDING TITANIUM CARBIDE-STEEL MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3(207), Mar 80 pp 30-33
manuscript received 22 May 79

NARVA, V. K., LOSHKAREVA, N. S. and USPENSKIY, L. G., Moscow Institute of Steel and Alloys

[Abstract] A study was made on improving the properties of titanium carbide-steel powder materials by chemical heat treatment. Alloys of titanium carbide and Kh6V3M steel containing from 0 to 40% TiC and different amounts of bound carbon in the titanium carbide (18.2%, 19.2%) were nitrided in ammonium at temperatures of 500, 750 and 1020° C and holding times of from 30 to 60 minutes. The initial powdered materials were mixed in a ball mill for 48 hours in alcohol. Pressed alloy specimens were sintered in hydrogen and then in vacuum. It was found that the hardness of the specimens increases with nitriding at temperatures of 500 and 1020° C followed by oil quenching, which can be attributed to diffusion saturation of the steel binder with nitrogen. The nitriding effects are enhanced by extending the time of saturation, reducing the TiC content in the alloys, and reducing the carbon defect of the titanium carbide. The thickness of the nitrided layer was determined by x-ray structural phase analysis and measurement of the microhardness of the steel binder from the nitrided surface toward the center of the specimens. Figures 3; references 6: 5 Russian, 1 Western.
[121-6610]

UDC 620.183.1

ELECTROCHEMICAL DETERMINATION OF THE MICROSTRUCTURE OF THE TRANSITION ZONE IN BIMETALS AND METALLIC COMPOSITE MATERIALS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3(207), Mar 80 pp 54-58
manuscript received after revision 28 Sep 79

DYBKOV, V. I., Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] Two solutions are proposed for electrolytic polishing of bimetals and metallic composites: both solutions contain various amounts of n-butyl alcohol, glycerin, perchloric, nitric, picric, tartaric, oxalic and citric acids and aluminum chloride, and in addition the first contains salicylic acid and is based on ethyl alcohol, while the second solution contains succinic acid and is based on methyl alcohol. The

electrolyte based on methanol should be used for polishing combinations of stainless steel and aluminum alloy, while the electrolyte based on ethyl alcohol is recommended for stainless-carbon steel bimetal. The proposed solutions have a working voltage range of 10-60 V. The working voltage is determined experimentally for each pair of metals. After achieving the required quality of polish, the voltage is dropped instantly to zero, and then slowly increased until the microstructure of all components is revealed. The etching voltage is generally 5-10 V. Figures 2; references 5: all Russian.
[121-6610]

RARE METALS

GERMANIUM EXTRACTED FROM COAL AT CHITA HEAT AND POWER PLANT

Moscow IZVESTIYA in Russian No 68, 29 Mar 80 p 6

[Article by A. Kleva, special IZVESTIYA correspondent, Chita: "Metal of the Electronics Age"]

[Text] In operation at the Chita TETs [heat and power plant] is a combined unit for extracting germanium from coal.

Just 20 years ago this semiconductor metal was extracted only from ore. Only countable kilograms were produced in the coke oven batteries of the Donets Coal Basin. Then germanium began to be produced for the first time as a byproduct of the generation of electric power at the Irkutsk TETs-1. It is true that here in burning germanium coal the electric separators trapped a meager amount of the rare earth metal. The rest flew off with the smoke into the atmosphere or was lost in the ashes. The country had to buy the metal abroad.

The USSR Ministry of the Coal Industry Institute of Fossil Fuels was confronted with the problem of developing a technology for more effectively utilizing the coal of the Transbaykal. Research suggested that it was necessary to modify the burning process. The Chita TETs proved to be the closest and most suitable in terms of technology. In a short time in conjunction with scientists was created a plant which made it possible to "retrieve" from a ton of ashes occasionally dozens of kilograms of the metal. The country began to obtain germanium in the required amount.

But new difficulties arose for the people in Chita. The pulverized germanium was trapped by special automatic separators in the form of a set of polyacrylonitrile fireproof bags. Since the coal happened to be supersaturated with sulfur, in the furnaces an acidic environment arose which the synthetic fabric restrained from power for several days. At that time we did not yet manufacture polyacrylonitrile. Innovators solved the problem of neutralizing the sulfuric acid by supplying ammonia to the gaseous medium. Since then each filter bag has lasted more than a year.

With the completion of debugging of the line at the TETs a piece of news arrived: In the Far East had been explored one other deposit of germanium coal which would also arrive here for processing. The head of the boiler section, Ye. Sukharevich, Machinist A. Pisarenko and Separator Operator Yu. Bobylev were involved in developing a system for the combined burning of this fuel of a different nature. Now it is taking place in a unified flow.

The Transbaykal boiler room is utilizing scarce coal to the maximum: It is producing energy and heat from it in addition to germanium. The large-capacity equipment is blocking the way for previously lost precious components. This has also helped in making the city's air basin sanitary. [117-8831]

8831
CSO: 1842

SINGLE CRYSTALS

FIANIT -- A NEW TYPE OF SINGLE CRYSTAL

Moscow IZVESTIYA in Russian No 50, 27 Feb 1980 p 2

[Article by Academician N. Belov: "How a 'Vicious Circle' was Broken"]

[Text] Most synthetic crystals inherit the name of their natural analogs -- quartz, ruby, sapphire, emerald, garnet and so on. However, there are also those that have no natural counterparts. Holding an eminent place among these "children of science" is a new group of crystals, the fianits, so named in honor of their birthplace the FIAN [*F*izicheskiy *I*nstitut *A*kademii *N*auk SSSR] (Physics Institute of the Soviet Academy of Sciences). Fianits are solid solutions with a cubic crystal lattice. Their chemical basis is zirconia and hafnia. These oxides are distinguished by extremely high melting points (2,700 and 2,800°C) and by high resistance to the action of acids, alkalis, molten metals and aggressive media.

We have said that fianits are not analogs of natural crystals. There is, of course, baddeleyite -- pure zirconium dioxide. But this crystal cannot compete with fianit, primarily because it is typified by a monoclinic rather than a cubic structure. Recently on the Tazheran alkali massif, which is located near Lake Baikal, a new mineral, tazheranit, was discovered that is comprised of cubic crystals of zirconium dioxide. The discovery of such natural crystals is certainly of great interest. Nonetheless, this mineral cannot compete with fianits either, since the very largest specimens of tazheranit measure no more than 0.5-1.5 millimeter.

The scientists who undertook the creation of the unusual crystals -- the fianits -- were "violating" a prohibitory law which at the time it seemed that nature had imposed on them: it was assumed that it was impossible to synthesize crystals with cubic structure from an oxide melt in the same way that [crystals of] refractory oxides and their compounds are grown (meaning ruby, garnet, alexandrite, rutile, scheelite, etc.).

Of course, if calcium, yttrium and rare earth elements are added to a mixture of zirconia and hafnia, solid solutions of the necessary structure can be obtained under certain conditions. But this is a far cry from synthesis of the crystals themselves.

A glance at the phase diagrams of binary systems might give the impression that synthesis of fianits is only a vain dream. Such diagrams imply that even if we should grow cubic crystals at high temperatures, they would change their structure to tetragonal and simply dissociate as they cooled to room temperature.

This obstacle seemed insurmountable, even though many technically valuable properties of zirconia and hafnia had been known for a long time. Among these are exceptional infusibility and chemical stability. Being excellent thermal insulators, they are capable of forming solid solutions with the most diverse oxides.

Such are the theoretical difficulties standing in the way of creation of the fianits. However, there were also technological difficulties.

Let us imagine one of the enterprises where artificial crystals are produced by growing from the melt, held in a crucible of some refractory material. Usually these are rare metals -- molybdenum, tungsten, or else inert platinum. This crucible containing the melt is heated either in an induction furnace or in a resistance furnace. Crystallization is done by pulling the object on a seed, or by lowering the crucible into a zone with gradually decreasing temperature. This is what is called directional crystallization in which large isolated crystals -- single crystals -- are grown.

What kind of a crucible can withstand an aggressive melt at a temperature of 2,700-2,800°C? As a liquid it interacts readily even with tungsten, the only metal that can withstand such heat. But heat resistance alone would not suffice here, and it was necessary to do away with the metal crucible altogether. The lack of a vessel for melting and crystallizing refractory substances like fianits turned into a serious scientific and technical problem. Until it could be solved, there was no point in thinking about production of a number of new crystals urgently needed by technology and the national economy.

The way out of this "vicious circle" was seen in principle by scientists of many nations. They reasoned: if we can't find a material for the crucible, why not make it out of the same dioxides that go into the melt?

The idea was reasonable. However, the trouble with putting it into practice was that the melt had to be heated from within by the inductive application of energy through the action of radio-frequency currents. And the oxides of zirconium or hafnium are dielectrics.

But in the mid sixties it was learned that when refractory dielectrics melt, there is a sudden increase in electrical conductivity. In other words, the melt ceases to be a dielectric, and can be completely heated by radio-frequency currents. Remarkably, with this original "acquisition" of electrical conductivity caused by the change in heating temperature of zirconium or hafnium oxides, their unmelted solid shell is changed to an unusual crucible that does not impede induction heating. By putting these new data into practice, scientists worked out an original technique for direct radio-frequency heating and crystallization of refractory dielectrics in a cold container.

The advantage of this method is that a high melting point is no barrier to heating. Of no less importance is the fact that the melt, being in its "native" shell, is spared from contamination. And we should add that the process can be carried out in any gas, including air. To produce crystals by this method, fundamentally new technological facilities were created that are now being used in many plants of our nation. Research by Soviet scientists in this field is at the center of attention of international conferences on crystal growing.

After developing the method of direct radio-frequency heating in a cold container, it was possible to go on to solution of the main problem -- producing refractory crystals based on zirconia and hafnia. Of course, this was preceded by hundreds of experiments on crystallizing melts of different compositions, penetrating studies of processes of phase transformations in the solid state, a minute study of the optical properties of the crystals and so on.

The great achievement of our scientists -- creation of a new class of crystals -- was predetermined by development of the necessary composition of the melt and conditions of its crystallization. We should emphasize the particular property of the crystal structure of fianits, which allows the introduction of the most diverse elements in concentrations up to tens of percent. Among these are rare earth elements, those from the iron group, vanadium, chromium, titanium, scandium and many others. Without disrupting the structure of fianits, these elements impart the most diverse properties, for example changing their density. Another example could be given that illustrates a change in the optical qualities of the crystals: in addition to exceptionally transparent colorless fianits, a totally black crystal has been produced that transmits light only in the infrared region of the spectrum.

A lot could be said about the fianits, but they are remarkable in that no natural or artificial crystals have a similar combination of physical and physicochemical properties. This is what makes fianits so promising for use in different fields of technology. Although they are based on oxides, which are known to be dielectrics, fianits are electrically conductive. And this is very important in the development of a number of devices. Transparency, high refracting capacity and other optical "talents" combined with high mechanical hardness, --these are the valuable properties that determine the high quality of lenses, prisms and other components of this kind. The chemically stable and refractory crystals can be used to make crucibles for melting aggressive metals and alloys. The fianits are also becoming the ancestors of new high-temperature materials, because they combine with the most "stubborn" partners. Such is the outlook for this new class of crystals developed by Soviet scientists.

For developing and studying the new class of single crystals -- fianits -- a group of scientists and technologists has been nominated for the Lenin Prize. I believe that they are worthy of this high honor. [109-6610]

6610
CSO: 1842

UDC 669.017

EFFECTS OF ANNEALING IN THE $\alpha + \beta$ REGION ON HIGH-TEMPERATURE CREEP OF PSEUDO α-ALLOYS OF TITANIUM

Ordzhonikidze IVUZ, TSVETNAYA METALLURGIYA in Russian No 1, 1980 pp 95-100

KARAKOZEV, E. S., RODIONOV, V. N., and PESHKOV, V. V., Moscow Evening Metallurgical Institute

[Abstract] A study was made of the effect of structural changes occurring in the process of annealing in the $\alpha + \beta$ region on high-temperature creep of pseudo α-alloys of titanium with initial fine-grained structure. Investigated were alloys OT4 of the Ti-Al-Mn ($As_3 = 960^\circ$ C) system and VT20 of the Ti-Al-Zr-Mo-V ($As_3 = 990^\circ$ C) system. It was found that annealing in the $\alpha + \beta$ region has a significant influence on the speed of temperature deformation, where ε depends on two factors: the size of the α-grain and the distribution of the particles of the β-phase. The possible mechanisms of high-temperature deformation of OT4 and VT20 alloys are discussed. Figures 8; references 14: 13 Russian, 1 Western. [97-1015]

UDC 669.295.017.13

THE METASTABLE PHASE COMPOSITION DIAGRAMS OF HARDENED TERNARY TITANIUM ALLOYS ALLOYED BY α- AND β-STABILIZERS

Ordzhonikidze IVUZ, TSVETNAYA METALLURGIYA in Russian No 1, 1980 pp 85-90 manuscript received 7 Jul 78

KOLACHEV, B. A., and BELOV, S. P., Moscow Aviation Technological Institute, Chair of Physical Metallurgy and Hot Metal-Working

[Abstract] In a previous article (IVUZ, TSVETNAYA METALLURGIYA, No 3, 1979) the authors showed that given a phase diagram of the ternary system it is possible to predict the metastable phase composition diagram of hardened alloys of this system. The present article discussed a metastable phase composition diagram of hardened ternary titanium alloys alloyed by α- and β-stabilizers, its projection, isometric cross-sections and vertical sections. Such diagrams might be useful in the selection of the optimum mode of heat treatment and their isometric sections may serve to predict the effects of the hardening and anticipated effects of the aging of hardened alloys. Figures 3; references 5: 4 Russian, 1 Western. [37-1015]

UDC 669.295'71'292:537.533.35

FEATURES OF THE LAMINAR STRUCTURE OF LIGHTLY DOPED PSEUDO-ALPHA TITANIUM ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 48, No 3, Sep 79 pp 563-574 manuscript received 17 Oct 79

NESTEROVA, YE. V., RYBIN, V. V. and OBUKHOVSKIY, V. V.

[Abstract] The transmission electron microscope was used to study the crystallographic characteristics of the laminar structure of two typical pseudo-alpha titanium alloys: 1) Ti-4.7 Al-2V; and 2) the same alloy modified with 0.004 wt.% boron. The study covered determination of the disorientations of adjacent platelets of alpha phase, including platelets belonging to the same and to different colonies, construction of the distribution functions with respect to angles of disorientation, determination of the correlation of relative rotations of platelets within colonies, a detailed study of the particulars of the structure of boundaries and the layers on the boundaries, establishment of the orientational relations between sections of alpha and beta phases situated both within a single colony and in different colonies, and determination of the effect of boron modification on these characteristics. It was found that the orientation difference for plates of alpha phase in the same colony is small (0±2°), and that the vectors of disorientation are compensated so that orientation does not accumulate in a colony as a whole. The vectors of disorientation of adjacent alpha phase colonies correspond to different versions of orientational relation to the initial beta phase. The layers of beta phase belonging to either the same or different colonies are not strongly disoriented relative to one another, and retain the orientation of the initial beta phase. A comparison tf the crystallographic characteristics of both alloys shows that modification with boron affects only the concentration of alpha phase nuclei, and does not alter the general nature of the $\beta \rightarrow \alpha$ phase transition. Figures 7; references 10: 7 Russian 3 Western.
[114-6610]

UDC 669.295:621.785:539.377

INFLUENCE OF ROLLING CONDITIONS ON THE BREAKING TOUGHNESS OF VTZ-1 ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 1, 1980 pp 53-55

IVANOV, A. S., TOMSINSKIY, V. S. and SHISHKINA, M. I., Perm' Polytechnical Institute

[Abstract] The structure and properties of titanium alloys are determined by conditions of plastic deformation. In this paper the authors study the dependence of breaking toughness of VTZ-1 alloy on conditions of deformation. The specimens were rolled in one pass at 820, 950 and 1050° C to a reduction of 40 and 60% with subsequent cooling in water and in air. Standard techniques were used for determining the yield stress at residual deformation of 0.2%, the ultimate strength and the ductility. The breaking toughness parameters (coefficient of stress intensity and critical opening of a crack) were determined on special specimens by a previously developed method. It was found that the highest breaking toughness parameters occur when VTZ-1 alloy is deformed at a temperature close to the point of $(\alpha + \beta) \to \beta$ transformation with cooling in air where the β-transformed structure has minimum β-grain size with sections of α-phase located along the boundaries of these grains. Figures 1; references 6: 5 Russian, 1 Western. [115-6610]

UDC 669.295'71'6:669'295'71'292:539.4.015

CHARACTERISTICS OF PLASTIC DEFORMATION AND DESTRUCTION OF Ti-Al-Sn AND Ti-Al-V ALLOYS AT LOW TEMPERATURES

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 48, No 3, Sep 79 pp 594-601 manuscript received 25 Jul 78

AGEYEV, N. V., RUBINA, YE. B., BABAREKO, A. A., BETSOFEN, S. YA. and BUNIN, L. A., Institute of Metallurgy imeni A. A. Baykov, Academy of Sciences USSR

[Abstract] An investigation was made of the mechanism of deformation of ternary alloys of titanium with aluminum and tin, and with aluminum and vanadium in the temperature range from 4.2 to 293° K. Tension was applied on an Instron testing machine at a rate of 5 mm/min. The volumetric content of twins was found by studying the microstructure of the specimens on an optical microscope. The mechanism of plastic flow was determined from the change in grain orientation. The width of x-ray diffraction lines was used to evaluate residual microdeformations and calculate internal microstresses. The results showed high inclination to twinning in the Ti-Al-V alloy in contrast to weak twinning in the Ti-Al-Sn alloy. The principal mechanism of deformation of the Ti-Al-V alloy at 20 and 77° K was twinning $\{1\bar{1}23\} \langle 11\bar{2}\bar{2} \rangle$. At room temperature, moderate twinning was accompanied by slip development. Deformation at 4.2° K took place due to twinning $\{11\bar{2}4\{ \langle 22\bar{4}\bar{3} \rangle$. Internal stresses in twins were relaxed by secondary twinning along planes $\{1012\}$. Correlation was observed between the mechanical properties of the Ti-Al-V alloy and the fraction of twins, and also the magnitude of internal stresses in the lattice. The nature of fracture of the Ti-Al-Sn and Ti-Al-V alloys was found to depend on the level of the internal stresses that arise under plastic deformation, and on the relaxation mechanism.

Inhibited relaxation in the Ti-Al-V alloy at 20° K produced a faceted-type fracture in contrast to a cellular fracture at 77 and 293° K, and a cellular-faceted fracture at 4.2° K. Figures 5; references 10: 4 Russian, 6 Western.
[114-6610]

UDC 669.295:620.179.18

DETERMINATION OF THE ENERGY OF INTERACTION BETWEEN IMPURITY ATOMS AND DISLOCATIONS IN TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 1, 1980 pp 52-53

BELETSKIY, V. M., MAKSIMYUK, P. A., TARACHNIK, V. I., GRINIK, E. U.
and GRITSKEVICH, A. L.

[Abstract] An investigation is made of the way dependence of internal friction of technically pure titanium and VT22 titanium alloy on temperature and amplitude of relative deformation. The internal friction of pure titanium remains constant up to about 300° C, and then begins to increase. Temperature dependence for VT22 alloy is similar, except that the increase in internal friction begins at about 400° C. In addition, the background of internal friction is higher for the alloy. Internal friction in VT22 alloy remains constant with increasing deformation amplitude up to a certain critical value, where internal friction abruptly rises. The amplitude curves for the pure metal are similar, but the background of internal friction is lower. Thus the results show that doping raises the energy of interaction of atoms, which explains the higher breaking strength of VT22 alloy. Figures 2; references 3: all Russian.
[115-6610]

UDC 620.194

CORROSION CRACKING OF AT3, AT6 AND VT14 TITANIUM ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA METERIALOV in Russian Vol 16, No 1, Jan-Feb 80 pp 36-42 manuscript received 14 Jun 79

VASILENKO, I. I., MELEKHOV, R. K., LEBEDEVA, N. G. and KOVAL', M. V., Physico-Mechanical Institute, Academy of Sciences UkrSSR, L'vov

[Abstract] AT3, AT6 and VT14 industrial titanium alloys were subjected to corrosion cracking tests in NaCl (3%) and H_2SO_4 (5-20%) concentrations. After fractographic analysis of the corrosion tests it was determined that in these alloys in NaCl, saturated with 3-3.5 mg/l H_2S, the presence of hydrogen sulfide has little effect on the long-time corrosion of AT3 and AT6 in comparison with corrosion stability in the chloride medium with pH = 1 or 6.5. Cracking is of a ductile nature with insignificant elements of a brittle nature. In VT14 the alpha-phase is responsible for nucleation and propagation of cracks in a brittle fashion since the beta-phase ruptures in a ductile fashion. The high stability of VT14 to sulfuric acid is associated with the features of hydrogen concentration in two-phase alloys. If hydrogen is dissolved in alpha-alloys, only in the alpha-phase, then in two-phase alloys it is concentrated primarily in the beta-phase and at the phase boundaries and this is where corrosion cracks develop. Thus VT14 possesses the best stability to corrosion cracking in either solution than its single-phase counterparts. Figures 6; references 9: 8 Russian, 1 Western.
[104-6368]

UDC 621.791.72

ION-BEAM WELDING OF THE VT6 TITANIUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, 1980 pp 69-70

GABOVICH, M. D., Doctor of Physico-Mathematical Sciences, PROTSENKO, M. N., Candidate of Physico-Mateematical Sciences, PORITSKIY, V. YA., Engineer, GUREVICH, S. M., Doctor of Technical Sciences, ZAMKOV, V. N., Candidate of Technical Sciences, and SHEVELEV, A. D., Engineer

[Abstract] The use of dense ion beams for welding titanium, niobium and vanadium in a vacuum with controlled gas loss from the seam wes tested on the VT6 titanium alloy using an ion flow of up to 1 kilovolt with a specific power of about 10^4 volt/cm^2. Despite low oxygen concentrations that harden titanium, the bonds showed durability equivalent to that of the original metal, apparently as a result of carbon fixed in the seam. X-ray and metallographic examinations of longitudinal and lateral sections showed a lack of cracks or pores, indicating that the process is superior to electronic beam welding. Figures 2; references 3: all Russian.
[96-12,131]

UDC 621.791.72:669.715

LATERAL CONTRACTION AND DEFORMATION IN THE ELECTRON BEAM WELDING OF THE 1201 ALUMINUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, 1980 pp 41-43 manuscript initially received 1 Feb 79, in final form 10 Apr 79

BONDAREV, A. A., Candidate of Technical Sciences, and TRETYAK, N. G., Engineer, Electric Welding Institute im. Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] Lateral contractions in the weld seam and the heat affected zone were measured in relation to such thermal factors as the thickness of the metal being welded, which varied from 5 mm to 250 mm. Current feed sources of 60 and 120 kilovolts were used, and the welding was performed without bead separation and without clamping, in both the vertical and horizontal planes. Results showed that with an increase in metal thickness, lateral contractions grew on the weld face of the seam, but remained essentially unchanged on the other face. With increased welding aperture, contractions were greater on both sides. Deformation of the collars welded in the test occurred if the metal thickness was below 65 mm. Figures 6; references 3: all Russian.
[96-12,131]

UDC 621.791.052.08

THE CORROSION RESISTANCE OF WELDS 15G2AFD LOW SILICON-CONTENT STEEL IN SEA WATER

Kiev AVTOMATICHESKAYA SVARKA in Russian No 2, 1980 pp 64-66 manuscript initially received 17 Jan 79, after reworking 3 May 79

LOS', YE. P., and BUT, V. S., Engineers, ASNIS, A. YE., Doctor of Technical Sciences, and IVASHCHENKO, G. A., Candidate of Technical Sciences, Electric Welding Institute, Academy of Sciences UkrSSR

[Abstract] The corrosion resistance of 15G2AFD steel welds on hot-rolled normalized steel welded without preheating was analyzed according to metallographic parameters. The low-silicon steel showed a slightly dispersed ferrite-perlite structure with 10-11 granular size. After welding, the joints were tested for potential variations between the original metal and the welds, in a 3% sodium chloride solution. Corrosion was measured by prophilometer and visually. The tests showed that the 09G2 and 09G2S control steels underwent continuous and irregular corrosion, while the 15G2AFD sample showed lesser, and even, corrosion. The weld seam had the same or less corrosion damage. Figures 1; references 2: both Russian. [96-12,131]

UDC 621.791.052.011:539.3

ANALYSIS OF THERMODEFORMATION PROCESSES IN THE HEAT-AFFECTED ZONE WHEN WELDING HIGH-TEMPERATURE NICKEL ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1(322), Jan 80 pp 11-15 manuscript received 23 Jan 79

EYDEL'SHTEYN, V. YE., engineer, Kuybyshev, YAKUSHIN, B. F., Candidate of Technical Sciences, Moscow, MAKHNENKO, V. I., Corresponding Member of the Ukrainian Academy of Sciences, and VELIKOIVANENKO, YE. A., Candidate of Physical and Mathematical Sciences, Kiev

[Abstract] The thermodeformation process is calculated in the heat-affected zone of a nickel alloy weld, and it is shown how this process depends on the thickness of the metal and on welding conditions. The calculations were done on a Minsk-32 computer by a technique in which the temperature and deformation problems are solved in the cross section of a plate with consideration of the form of edge dressing, assuming simultaneous welding over the entire length of the seam. Data were compared for EP199 high-temperature nickel alloy and grade 25 low-carbon steel. It was found that the combination of low thermal conductivity and retention of mechanical properties at high temperatures disrupts the synchronism of thermal and deformation processes of EP199 alloy in the heat-affected

zone, so that tensile stresses increase at an exceptionally high pace. This results in hot cracks near welds. When parts thicker than 3 mm are welded, the vector of maximum tensile stress in the heat-affected zone for the brittle temperature range is directed along the z-axis, the rate of increase in this deformation being maximum in the middle of the sheet. With increasing thickness, the rate of stretching with respect to the thickness of the sheet changes, passing through a maximum at 10-15 mm. The way that the pace of tensile deformation with respect to plate thickness depends on the running welding energy also is described by a curve with a maximum. However, under conditions of argon-arc welding, the stretching rate of the metal and its inclination to hot cracking in the heat-affected zone increase with decreasing thermal input. When welding EP199 nickel alloy 8-12 mm thick, the inclination to hot crack formation in the heat-affected zone is minimum for a running energy of 9,000-12,000 J/cm. Figures 7; references 10: all Russian.
[94-6610]

UDC 621.791.052:620.193

OXIDATION BY HYDROGEN FLUORIDE OF WELDING SEAMS BASED ON NICKEL ALLOYED WITH TITANIUM, CARBON AND SILICON

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 80 pp 9-11

KUZ'MIN, G. S., Candidate of Technical Sciences, and MOCHALOVA, T. F., Candidate of Technical Sciences, Perm Polytechnic Institute

[Abstract] The single compound which nickel forms with hydrogen fluoride, namely nickel fluoride, has a volume increment index $\Delta = 3.17 > 1$ and thus serves as a corrosion inhibiting protective layer on the pure metal. A study was made to determine the effect of three alloying elements (titanium, carbon, silicon) in nickel welding seams on the corrosion resistance of the metal in an atmosphere of gaseous hydrogen fluoride. Each alloying element was added in powder form to $CaO\text{-}CaF_2\text{-}Al_2O_3$ ceramic fluxes for welding NP2 nickel strips (10 mm thick) and wires (4 mm in diameter) on an ADS-1000 automatic welder at the rate of 24 m/h (d.c. voltage 30-32 V, current of reverse polarity 520-540 A). Corrosion measurements were performed over a period of 120 h at 550° C under a pressure of 20 atm, with the surface condition, i.e., the nature of the bond to fluoride films as well as the weight loss factor and the degree of intergranular corrosion serving as indicators of the corrosion rate. The latter has been plotted simultaneously as a function of the alloy content and as a function of the test time. These three-dimensional diagrams as well as a 5-zone chemico-structural model ($Ni\text{-}Ti/Ni/NiF_2/$ oxidation$/NiF_2$) of the surface layer, based on thermodynamic data pertaining to selective oxidation reactions, indicate that addition of

0.10-0.30% Ti, 0.10-0.20% C, or 0.10-0.30% Si accelerates formation of the protective film. Rather than reducing the corrosion resistance by causing porosity in this film, these elements tend to deoxidi e the base metal. Figures 4; references 8: all Russian.
[112-2415]

UDC 621.791.4:539.378.3

DIFFUSION WELDING OF ANGLE BRACKETS MADE OF THE VT20 TITANIUM ALLOY

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 80 pp 34-35

MAYDANOV, L. P., engineer, LEVTOVA, K. A., Candidate of Technical Sciences, SIGACHEV, A. N., engineer, KOTEL'NIKOV, A. A., Candidate of Technical Sciences, and MATYUSHKIN, B. A., Candidate of Technical Sciences

[Abstract] Diffusion welding instead of milling after forging increases the metal utilization factor threefold and reduces the labor content in production of ribbed panels and angle brackets made of titanium alloys. A study of this process was made on angle brackets using the medium-strength VT20 titanium alloy (6% Al, 2% Zr, Mo and V added). A special tool was built for this purpose which included a pneumatic clamp consisting of shells stacked on top of a base pad with cavities between them so as to facilitate producing a large set with a small deformation, also a plunger and a chuck for holding the parts, all inside a frame made of a heat risistant alloy and, after assembly held tight by wedges. Before welding in this fixture, the surfaces of parts in contact had been coated with a 0.2-mm-thick ZrO_2 film, to prevent seizing. After welding for 60 min in a CBK vacuum furnace at 960° C (optimum temperature without excessive grain growth) under a pressure of 2.0 kgf/mm^2, the samples were tested for tensile, impact and fatigue strength. Despite the side spread of test data, the clear indication is that diffusion welding yields better strength characteristics, especially a longer endurance under cyclic load, than argon-arc welding and than milling after forging. Fracture was found to occur not in the seam but in the base metal. The process has already been introduced for pilot production of angle brackets. Figures 4.
[112-2415]

UDC 621.791.72.01

PROCESSES OF MELTING OF METAL AND FORMATION OF THE SEAM DURING ELECTRON-BEAM WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 79, pp 4-6, 28
manuscript received 19 Mar 79; after revision 31 May 79

LESKOV, G. I., Doctor of Technical Sciences, NESTERENKOV, V. M., ZHIVAGA, L. I., Engineers, Electric Welding Institute imeni Ye. O. Paton, Academy of Sciences UkrSSR

[Abstract] A study was made of the heating, melting and evaporation of metal through the height of a channel formed in electron-beam welding. Estimates were made of the magnitudes, points of application and direction of forces and pressures in the channel. This was done by rapidly (within 10^{-3} sec) cutting off the beam of the electron gun, then examining the metal sections. It was found that the deviation of the shape of the anterior wall of the channel from the equilibrium shape depends on the thermophysical properties of the metals being welded and the welding regime. The concentration of power in some projections in the channel was 2.5 times the equilibrium concentration. This high concentration energy caused local melting and evaporation of the anterior wall of the channel. Figures 5; references 5: 3 Russian, 2 Western.
[88-6508]

UDC 621.791.72:669.295

FORMATION OF PORES IN WELDED JOINTS OF VT6 TITANIUM ALLOY MADE BY THE ELECTRON-BEAM METHOD

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 79, pp 50-54, 57
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[Abstract] An analysis was made of the mechanism of formation of pores in butt-welded seams in VT6 alloy, produced by the electron-beam welding method. Thermodynamic analysis of possible chemical reactions during welding of titanium and experimental data involving taking of gas samples during melting of titanium ingots indicated that if there are no contaminants in the joint, two reactions can occur: production of atomic hydrogen and combination of carbon and oxygen to form carbon monoxide. Photomicrographs of polarizing and welded seams in this alloy are presented. It was concluded that the porosity results from the liberation of atomic hydrogen during melting and crystallization of the metal. It is recommended

that the concentration of hydrogen in the base metal be decreased, that welding be performed at low speeds or that remelting of the seam metal be used to avoid this problem. Figures 7; references 15: 14 Russian, 1 Western.
[88-6508]

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ELECTROSLAG WELDING OF MEDIUM ALUMINUM-MAGNESIUM ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 79 pp 43-44, manuscript received 4 Jan 78; after revision 4 Jun 79

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[Abstract] In order to study the weldability of an alloy consisting of aluminum plus 3.8-4.8% Mg by the electroslag method, strips 50 mm thick were welded with a plate-type electrode alloyed with zirconium and magnesium. The composition of the alloy was (%): Mn 0.53, Fe 0.25, Cr 0.065, Si 0.1, Cu 0.075, Zn 0.04, Mg 4.8, remainder -- aluminum. The chemical composition of the flux was (%): KCl 50, LiCl 20, $BaCl_2$ 20, AlF_3 8, LiF 2. Photographs of the macro- and microstructure of the welded seams are presented. The mechanical properties of the joints produced were found to depend on the content of alloy elements and their properties. Zirconium as used in this experiment greatly increased the strength of the welded joint. Figures 1; references 11: 3 Russian, 8 Western.
[88-6508]

GRANULAR METALLURGY DEVELOPMENTS NOTED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 33, 9 Feb 80 p 2

[Article by A. Belov, director of the All-Union Scientific Research Institute for Light Alloys: "Through New Technologies"]

[Text] The problem of metal production and use is presently quite acute. This was pointed out to us by the November Plenum of the CPSU Central Committee. In his speech, comrade L. I. Brezhnev named three basic problems. Firstly, basic qualitative changes in metallurgy are carried out too slowly. Secondly, introduction of new technological processes in the key metal-consuming sectors is lagging. Thirdly, there is outright squandering of metal. These three observations also apply to aluminum, which we are concerned with here.

In regard to volume of output, aluminum is the most important of all the nonferrous metals and it is more and more extensively used in the most diverse sectors of the national economy. As can be easily illustrated by its use in agriculture, further development of aluminum production is very advantageous in every respect. Through the use of aluminum, it is possible significantly to expand the construction of hothouses and irrigation systems. Semimanufactures made of aluminum alloys have good technological properties and are not subject to corrosion; this sharply reduces the metal input required for installations as well as labor input.

No less important is the task of reducing the losses in agricultural output during harvesting, processing and storage. Through construction of aluminum graneries, which can quickly be erected under kolkhoz and sovkhoz field conditions, especially in remote and barely accessible regions, it would be possible to preserve for the country a large quantity of grain. There are designs for graneries, which could be assembled in 30 to 50 hours.

Construction of livestock and poultry farms with aluminum elements likewise offers great advantages. Finally, for agricultural products to reach the consumers with minimum losses, it is necessary to establish an extensive network of canneries, especially in the places producing vegetables, fruit, and dairy and fish products. Such projects likewise require aluminum.

One could name other sectors of the economy, in which aluminum is indispensable. By means of aluminum, it is possible to create new progressive forms of agricultural machinery and specialized transport.

In short, in summing up all the urgent requirements of the agroindustrial complex, one obtains an impressive figure--600,000 tons of aluminum per year. How can we obtain such an increase in the output of the light metal? Scientists have drawn up recommendations and propositions that make it possible to achieve this with minimum input of labor and capital. It is necessary to change the presently accepted principles concerning the siting of enterprises of the aluminum industry.

The raw materials for many of these enterprises have to be transported over long distances. Moreover, these enterprises demand that the output of the power stations that supply them with power remain strictly constant. In addition, they require a lot of heat. But the output of hydroelectric power stations varies in accordance to the river flow. In order to compensate for such fluctuations, the plants must be provided with a supplementary hookup to thermoelectric power stations.

All these problems will be solved, if we apply new principles regarding the siting of enterprises of the aluminum industry.

We feel one should consider establishing a nuclear-metallurgical aluminum complex with an output of 600,000 tons. It should consist of an alumina plant with an ore base, an electrolysis plant, a rolling mill and a nuclear thermoelectric power station--ATETs. This will assure the metallurgists of a constant power supply and of sufficient heat; it will allow significantly to reduce the volume of capital investments, since there is no need here for heat or power transmission lines. There will be none of the losses which are inevitable in the transmission of power over long distances. The transport sector will be freed from hauling millions of tons of raw materials and fuel.

We should speed up the introduction of fundamentally new technological processes. In particular, I would like to talk about granular metallurgy, which despite its resemblance to powder metallurgy is essentially a new technology. In contrast to powders, the grains are obtained through atomization of the metal bath. This helps to insure a high rate of crystallization. The grains are then placed in a form and compacted at a high temperature and pressure. Thus one obtains a highly homogeneous structure.

We completed an important stage in the development of this technology. By means of isostatic compression, high-alloy materials were produced from the grains obtained by the high-speed metal crystallization. By traditional methods, it would have been impossible to obtain these materials. Besides improving the product quality, the new technology allows sharply to lower metal input and to reduce the mechanical processing in the production of components. At the same time, the demand for fresh charge materials is reduced to one-half; in the long term, it will decrease to approximately one-third.

Through its own efforts, our collective designed and produced industrial test equipment, including furnaces and special equipment for preparing the charges. For producing the grains, the collective has designed centrifugal installations with complex gas-purification systems. There has been developed a system for classifying the powders obtained according to grade and according to their purification by the ionic process.

In many respects, however, the fate of these long-range scientific plans depends on the production of new equipment. Not a single ministry for machine building has as yet started to develop the new machines, furnaces and complex vacuum technology. At best, the ministries can provide individual, separate elements, which must be consolidated by the developers of the process. It goes without saying that such conditions cannot be regarded as normal.
[99-8760]

8760
CSO: 1842

MONOKRISTALL INSTALLATIONS USED IN PLASMA TECHNOLOGY

Moscow MOSKOVSKAYA PRAVDA in Russian No 44, 21 Feb 1980 p 1

[Article by A. Presnyakov]

[Text] There are quite a few sensational events in the variegated history of refractory metals and carbides. The sintering of metal powders into finished items was a landmark of its day. The separate particles of the powders adhered, forming a monolithic mass. Researchers and engineers then turned to the electron beam. This allowed them to produce cast articles from refractory metals. But even this technique was powerless for solving new important design problems.

It was only when researchers had mastered plasma heat of electrically charged gases that new possibilities were opened up for metallurgy. Plasma technology is realized in Monokristall facilities.

In the first models of such units, the initial raw material for melting single crystal ingots was provided by tungsten bars that had been made by sintering from the powder. A series of Monokristall installations has now been developed and produced in which the ingots are melted directly from the tungsten powder. The process has been accelerated, greatly reduced in cost, and simplified.

...An impressive kind of machine can be seen in the shops of the special design office at the Institute of Metallurgy. In a unified complex, this machine combines a plasma melting unit and a system for automatic control, regulation and monitoring.

The melting point of tungsten is 3,380°C. A temperature of 10,000-12,000 degrees Celsius reigns at the heart of the plasma stream. In such a Hell even the "champion of infusibility" cannot hold out; it melts and begins to settle as misty rain on the starter seed crystal. Obeying the law of nature, the tungsten grows layer by layer as a crystal with a single structure. In accordance with the "design" assigned by the operator, the metal copies the shape of the seed. And before our eyes stands a heavy ingot.

"Under these conditions, powder is the initial raw material, so we can use quite brittle substances from which it has been almost impossible up until now to make workpieces before melting" explained Doctor of Technical Sciences G. S. Burkhanov, one of the developers. "When we use powder, we can easily vary the composition of the charge and produce single crystals of complex compositions made from previously unknown structural materials with predetermined physical and mechanical properties. And the high temperature of the plasma keeps out foreign impurities of metals and alloys. On these installations we can produce large items with various profile shapes, including plates, pipes and bars."

Through electronics, the melting can be done automatically. Electronics also enables on-line operation with computers, which can replace a skilled operator. The entire technological process can be done according to a preset program.

"The interdepartmental committee has given the Monokristall installation high marks" says V. M. Mishin, director of the special design office of the Institute of Metallurgy. "Success has been aided by the close contacts maintained by designers with scientists of the institute labs."

The melting units have been released for installation. The collective of the Institute of Metallurgy has marked out new lines for worthy celebration of V. I. Lenin's 110-th birthday.
[108-6610]

6610
CSO: 1842

RATIONAL USE OF METAL RESOURCES

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 61, 13 Mar 80, p 1

[Report on speech given by Academician A. Ishlinskiy, chairman of the All-Union Council of Scientific and Technical Societies]

> [Text] The 5th Plenum of VSNTO--All-Union Council of Scientific and Technical Societies took place yesterday in Moscow, at which there was a speech on increasing the role of the scientific and technical societies in the area of searching for reserves of metal and the rational utilization and economy of their use. The chairman of VSNTO, Academician A. Ishlinskiy, said the following on the basic tendencies of this great project:

Among the most important problems brought up for discussion at the November (1979) Plenum of the CPSU Central Committee, Leonid Il'ich Brezhnev particularly singled out the problem of the economical use of metal. "In spite of the huge scale of production of metal," he noted in his talk, "it is not as abundant as it was formerly."

What are the reasons for this deficit? It is not only the increasing growth in the use of metal, but also in how we make use of the supplies we do have. It is no secret that many valuable components of crude ore end up as waste products at the stage of extraction and primary processing. This occurs because nonferrous metals "do not interest" ferrous metallurgy, ferrous metals "do not interest" nonferrous metallurgists. Until now there has not been enough attention paid to the problems of removing the metallic components from the waste products of various production stages. For example, in the making of synthetic fibers slurries are formed which contain up to 40 percent zinc. For chemists they are harmful waste products, whose neutralization and storage require large expenditures. But for metallurgists they could become a valuable raw material.

Analysis shows that the greatest losses of ferrous metals occur during their production. If all the metal arriving in aggregates for smelting of steel is taken as 100 percent, then it turns out that only 72 percent of it ends up in the final product, and about 6 percent is irretrievably lost in the form of oxides and fumes. Searching for solutions which will permit one to reduce these losses is an extensive field of activity for the scientific and technical community.

The use of various methods for strengthening rolled steel products at the manufacturing stage offers great possibilities for metal conservation. However, even thermal strengthening -- a method which does not require large capital outlays -- has not been rapidly introduced: only about 6 percent of rolled products are strengthened by thermal treatment in our metallurgical enterprises.

Moreover, if the critical parts of machines and equipment are made of strengthened rolled steel, then the weight of the structure can be decreased by 20 to 35 percent. Why do we still underutilize these reserves? It seems that herin lies the greatest obstacle -- it relates to the tonnage factor: thermal treatment of metal goods does not increase it, but the human labor expenditures of metallurgists increase. One of the greatest demands for metal is in machine building. Unfortunately, it happens frequently that the metal used in building machines is immeasureably high. Thus, for example, in the "EO-6121" Excavator, produced by Minstroydormash [Ministry of Construction and Road Machinery Manufacture] the weight of the design is 9 tons more than a similar foreign model, and the "KB-405-2" Tower Crane exceeds its counterpart in metal consumption by 26 tons.

The ways of solving this problem are many and varied. However, I will mention only one of them. As is known, the decree adopted last year by the CPSU Central Committee and the USSR Council of Ministers on improving planning and economic procedures envisages periodic expert evaluation of the technical level of goods, machinery and equipment produced. It appears that the scientific and technical community should play the most important role in this important work. Especially since we already have specific experience in this area.

A Provisional Expert Commission of VSNTO studied the possibility of replacing metal by polymer materials in agricultural equipment. Analysis of the designs of "Belarus'" type tractors and "Niva" and "Kolos" type harvesters showed that polymers cannot only compete successfully with metal, but can also have a number of advantages. Their use in place of rolled sheet steel reduces the weight of a design and fuel consumption, increases the useful capacity of an engine, and increases the overall technical efficiency. Such studies must be made in other branches.

The logic of our actual situation is such that even after the machines and equipment go on-line the expenditures of metal for them do not stop -- it is used in making spare parts. It is assumed, for example, that before the "T-130" tractor is written off, just as much metal is used in making spare parts for it as it itself weighs -- about 12 tons!

How can this problem be solved? Many economic managers believe that the production of spare parts must increase in the future. However, such an approach seems inadequate to us. Transition to the system of industrial, company overhaul can be a real counterproposal to it, along with an increase in longevity and reliability of the machines. The sense of this system is simple: whoever makes something repairs it. "AvtoVAZ," the Vil'nyus Fuel Apparatus Plant, has taken this approach. This experience should be closely studied and disseminated: for, according to calculations of specialists, approximately 4 times more effort is expended on repairs in the traditional approach than in company maintenance.

The struggle to economize and efficiently use metal is not a problem which can be solved in one day. It is a constant and tedious program. To carry it on, scientists, engineers and production innovators must mobilize all available methods and means. Many problems become more complex each day. Therefore, they must be solved today on a scientific basis, with consideration of the future prospects.
[118-9424]

9425
CSO: 1842

NEW ROLLING MILL SYSTEM FOR PRODUCING HIGH-PRECISION SHAPES COMMENDED

Moscow IZVESTIYA in Russian No 67, 20 Mar 80 p 3

[Article by P. Polukhin, rector, Moscow Institute of Steel and Alloys, Hero of Socialist Labor, professor and doctor of technical sciences: "Unique Mill"]

[Text] In rolling,metal fluctuations are constantly observed in the dimensions of the starting stock, the rolling temperature and mechanical characteristics. In existing mills with low-rigidity roll stands this results in a broad field of tolerances for the dimensions of rolled shapes. As a result, the quality of products is worsened and much metal is lost.

How to reduce these losses and achieve an increase in finished rolled metal without the additional smelting of steel is an exceedingly important problem. It is precisely along this line that two leading collectives of the country have concentrated their efforts--scientists and designers of the Scientific Research and Planning and Design Institute of Metallurgical Machine Building (VNIIMETMASH) and metallurgists of the Cherepovets Plant imeni the 50th Anniversary of the USSR.

Beginning in the 60's specialists of the institute and plant in close cooperation conducted a combination of basic, theoretical, technological and experimental research on processes of rolling precision shapes and on its basis created a fundamentally new system of rolling mills with high-rigidity roll stands which do not have analogs in world practice.

In the new stands rigidity has been increased eight- to 12-fold as compared with the traditional. This has made it possible to improve considerably the precision of rolled shapes. As the result of a drastic reduction in the weight of the new stands and in their overall dimensions, it has proven possible to install in the spaces between the mill's stands a new automatic regulation system making possible the continuous rolling of a wire rod without strain. This has made it possible to create total stability for the rolling process and has increased the output of suitable metal by 1.5 percent. An improvement in the quality of rolled metal has been achieved also because of the creation of an efficient system for thermal hardening of the rolled metal.

The new system of mills has been introduced at the Cherepovets Metallurgical Plant. It is made up of a model 250 continuous wire mill, a model 250 continuous light-section rolling mill and a model 350 semi-continuous medium-section rolling mill. This system has undisputed advantages over the existing ones in the technical and economic respects.

During the time of operation, on the new mills of the Cherepovets Metallurgical Plant have been produced more than seven million tons of rolled metal. Furthermore, more than 250,000 tons of metal have been produced in addition without the smelting of steel, and the savings from introducing the new system has equaled about 60 million rubles.

The high scientific and technical significance of this work, submitted by the team at the Cherepovets plant in competition for the Lenin Prize, is characterized by the fact that a fundamentally new trend in the science and technology of rolled metal production has been developed, without having analogs in world practice and reflecting a domestic priority protected by many copyrights and patents.

The problem discussed above was solved successfully under industrial conditions. It must be mentioned that the cardinal retooling of existing high-performance section and wire mills was performed without halting production, within a short period and with minimum capital investment. This was proven possible primarily because of unbroken communication between science and production and a comprehensive approach to solving the problem, both from the viewpoint of the theory of rolling high-quality shapes and of the simplicity of the construction created for roll stands in combination with automatic regulation systems.

The job done by the competitors for the high award has opened up new prospects for the retooling of the country's section mills and will make it possible to gain an annual savings of metal (without the additional smelting of steel) of more than one million tons.

The fundamentally new scientific and technical solutions which have been developed can be used both in section and in other types of mills, for example, in tube mills, cold rolling mills, narrow strip mills, etc. This will improve even more the quality and efficiency of the production of rolled metal and tubes.

A special place in the work project was set aside for drastically reducing the metal content of stands (2.5- to 4.5-fold) and for improving the reliability and operating life of equipment. The reduction in the weight of rolling mill roll stands is important both from the viewpoint of economizing on metal for making them, and of reducing their overall size, relieving foundations, reducing the capacity of load-lifting equipment, as well as of reducing labor costs in numerous operations of the cycle of manufacturing, assembling and operating the equipment of rolling shops.

The valuable experiment of the Cherepovets Metallurgical Plant and VNIIMETMASH is a clear example of the embodiment of the party and government line toward improving the efficiency of metallurgical production, and it deserves approval in every way possible and broad dissemination in the industry. The work project of the creative team of the institute and plant, "Creation of a Fundamentally New System of Mills for Rolling High-Precision Shapes," has been awarded the Lenin Prize.
[117-8831]

8831
CSO: 1842

THE RATIONAL USE OF METAL

Moscow TRUD in Russian No 62, 14 Mar 80 p 2

[Article by I. Melenevskiy]

[Text] Today our country occupies a leading position in the world in the extraction of iron ore, smelting steel and producing rolled products.

They descriptively call metal the bread of industry. It is natural that the more metal we produce the more successful we will be in moving our economy forward. However, is a quantitative expansion of metallurgical products the only possible means? Can't we, along with increasing metal output, widely introduce the newest scientific achievements, making it possible to save metal and replace it with other materials?

A serious and exhaustive conversation has been conducted on the paths of rational utilization and economy of metal which is just now being completed at the Moscow Plenum of the All-Union scientific and technical societies. Those taking part in this work are party workers, ministry and department advisers, advisers of professional union organizations, scientists, production innovators and representatives of the scientific and technical societies. The lecturer, representative of VSNTO, Academician A. YU. ISHLINSKIY, as well as the remaining speakers, noted that the scientific and technical societies introduced a specific contribution in the matter of lowering production metal capacity, using progressive design resolutions and improving technological processes.

An effective system of metal economy has been introduced at enterprises of the Chelyabinsk Oblast by the active participation of the scientific and technical society. The Georgian scientific and technical societies started a massive campaign under the motto "Each council of the Scientific and Technical Society is a headquarters for finding production reserves." Activists of the Scientific and Technical Society (STS) of the Rustav Metallurgical Plant performed much work. With their aid the output of rectangular pipe made of electroslag remelted steel has been mastered at enterprises. However, as underlined at the plenum, many organizations of STS Ferrous Metallurgy and STS Nonferrous Metallurgy do not take seriously solutions of problems of improving quality and expanding the assortment of metal production and the creation and introduction of new techniques and progressive technology.

Academician and member of the Presidium of the Armenian Republic Council of STS M. V. KAS'YAN, Director of the Section for the Noril'sk Administration of STS Nonferrous Metallurgy, and Laureate of the Lenin Prize YE. N. SUKHANOV spoke at the plenum on problems of more complete extraction of metal from ores and the skillful use of local substitutes for metallic materials.

Causes of irrational use of ferrous metals were subjected to serious examination at the plenum. It turns out that almost 30% of the entire quantity of finished smelting of steel is lost in the process of its production. Many tons of metal are sent to the dump in the form of oxides and wastes, carried out along with the gases. But an even greater loss of metal occurs when it is extracted from ore. In nature as a rule there is no single-mineral raw material. Its division into ores of ferrous and nonferrous metals is very conventional. Quite often this leads to non-agricultural use of the raw material due to departmental politics. For example, at the Kovdor Deposit (Kol'skiy Peninsula) and Darasun (Zabaykal'), where organizations of the Ministry of Ferrous Metals USSR prevail, up to 60% of the valuable components of ferrous metals is extracted but the zinc and lead are not used.

At the plenum it was emphasized that the primary organizations of STS should attempt a more active influence on fulfilling set batches of problems on the rational use and economy of metal.

Chairman of the Leningrad Oblast Council of STS, academician I. A. GLEBOV, Director of the polymer and composite materials section at the Institute of Chemical Physics academician N. S. YENIKOLOPOV, member of the Central Administration of the All-Union Chemical Society imeni D. I. Mendeleyev and Director of the Institute of General and Inorganiz Chemistry imeni N. S. Kurnakov, Academician N. M. ZHAVORONKOV, Chairman of the Committee for the All-Union STS for problems of conservation of the surrounding natural medium Academician B. N. LASKORIN and others talked about means of reducing metal losses.

For example at the Leningrad Trubostal' Plant the lowest coefficient of metal consumption in that branch of industry has been achieved. Due to the use of minus tolerances as well as introduction of automation of computing pipe weight and introduction of special attachments on the pipe cutting mills, 320 tons of metal was saved in the past year.

One of the effective means of saving is replacing metal with polymer parts. Unfortunately, this branch of industry is still in an incipient state. This year we will produce less than four million tons of polymer parts--several times less than in other developed countries. In fact, a ton of polymer replaces 5-6 tons of metal, which is especially important in the production of pipe. In the entire world a course on replacing metal with polymers in pipe production is being taken, yet we are only slowly mastering this progressive method.

Another example is the use of so-called composite materials. These are not even pure polymers. The latter are the bonding link of traditional materials but impart to them completely new properties. Scientists have developed many valuable composite materials. But until they reach the stage of wide industrial introduction nothing is achieved.

What then is hindering the practical implementation of leading scientific developments in the production? The chairman of the committee of the All-Union STS on problems of the practical use of material reserves, Doctor of Economic Sciences V. P. YEFIMOV told this to the plenum: --Meanwhile many enterprises are not saving metal. Why in mastering improved, highly accurate and special rolled shapes do the basic expenditures fall on the manufacturer and the advantages occur to the consumer? Obviously the question about changing this system is about to surface. Manufacturers should also receive a definite part of the economy achieved by means of using more modern materials.

It is known that in solving a problem of reducing metal consumption a large role is played by powder metallurgy. Doctor of Technical Sciences V. S. RAKOVSKIY, Chairman of the Commission on Powder Metallurgy of the Committee of the All-Union STS on Problems of the Rational Use of Material Reserves, Chairman of the Council for Primary Organization of STS of the ZIL union, M. M. FISHKIS, Chairman of the Central Administration of STS for the Machine Building Industry and Gereral Director of STS for Metal Cutting Mills, Professor V. S. VASIL'YEV and others spoke about this during their appearances. Manufacturing of machine parts and instruments by powder metallurgy makes it possible to consume 20-33% less metal.

For all the advantages of powder metallurgy it is only taking the first faltering steps. The main cause of this as underlined at the plenum, is that there is no master for the new method. In the Ministry of Ferrous Metallurgy USSR there are specialized plants of powder metallurgy but only a very small percentage of the overall production of this ministry is involved in powder metallurgy.

It was recognized at the plenum as being advantageous to intensify attention of the STS organizations to propagate powder metallurgy and to achieve creation of scientific-production departments of powder metallurgy in the country.

In recent years the STS became more objective in taking on the solving of problems of increasing machine reserves including the struggle with corrosion. This measure is most opportune. Meanwhile, according to the calculations of specialists, costs for repair and counter-corrosion protection amount now to 3-5 percent of the national product. Recently the committee of the All-Union STS for Corrosion Problems and Protection of Metals made a massive review of the objects and locations where special methods of combatting corrosion are required. Much attention to this problem was given by Chairman of the Central Administration of STS for Construction and Deputy Chairman of Gosstroy USSR I. I. ISHCHENKO and Chairman of the Central Administration of STS for Ferrous Metallurgy and Director of the Central Scientific Research Institute for Ferrous Metallurgy N. P. LYAKISHEV.

It was emphasized that up to this point in time there have been no specialized organizations for completing the entire complex of works in many branches on protection of metallic and reinforced concrete constructions from corrosion either in construction or in the process of operating buildings and equipment. The problem of corrosion is an interbranch problem and all organizations of the STS should be involved in its solution.

In the speech of Comrade L..I. BREZHNEV at the November (1979) Plenum of the Central Committee of the Party it was underlined that 1980 "is not only the concluding year of the present five-year plan but is also the basis on which to build the following five-year plan". In securing this base a large role is allocated to metal, without which a further growth of economic capacity of the country is inconceivable. There is no doubt that STS will make it all the more necessary for complete satisfaction of requirements of the national economy for metal.
[110-6368]

6368
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NITRIDE HARDENING OF PURE IRON AND IRON-BASED ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 1, 1980 pp 5-10

ANASHENKO, V. N. and GULYAYEV, A. P., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] The paper generalizes previous research by the authors on the influence of nitrides of vanadium and niobium on the structure and properties of pure iron and steel. The initial carbonyl iron was specially treated to reduce oxygen content, and extra steps were taken to improve degasification during melting of the alloys in a vacuum induction furnace. Chemically pure powders of the nitrides were added to the molten metal in predetermined amounts corresponding to stoichiometric ratios V/N=1 and Nb/N=1. It was found that insoluble nitrides delay grain growth. The effect is more pronounced for the less soluble niobium nitrides. After the nitrides have dissolved in alloys with vanadium nitrides, grain growth takes place by merging. The mechanism of grain growth is migration of boundaries in the case of niobium nitrides. The effect of the nitrides on mechanical properties is due to increased strength of the solid solution, dispersion hardening by nitride precipitation, and reduction of grain size. The ductile-to-brittle transition point is not affected by the strength increase of the solid solution, but is abruptly raised by precipitation hardening, and lowered by reduced grain size. In each specific case the ductile-to-brittle transition point is determined by the combined effect of these factors. Figures 5; references 11: all Russian.
[115-6610]

UDC 620.178.2

PHYSICAL FEATURES OF CRACK FORMATION AND GROWTH

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 1, 1980 pp 10-15

KRISHTAL, M. A. and EPSHTEYN, L. YE.

[Abstract] The article is a continuation of previous research by the authors on the disparity between the theoretical and actual strength of materials, crack development, the influence of structure on crack formation and growth [see M. A. Krishtal, L. Ye. Epshteyn, "Mechanical and Physical Features of Metal Destruction," METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV, No 4, 1978 p 2]. In the present paper the authors consider the problems of applying certain physical concepts to

investigation of crack behavior in loaded materials. The thermodynamic features of the behavior of a stressed solid with cracks and pores are analyzed on the basis of determination of Laplace pressure at high temperature. An examination is made of the formation of pores and cracks resulting from condensation of excess vacancies with heating of the material in slip bands. As the cracks grow by interaction with dislocation pileups, they may become blunter or sharper, retarding or accelerating further movement. Dislocation networks are a barrier to crack growth. An examination is also made of high-speed crack growth with high strain rate deformation of metals. Figures 4; references 9: all Russian.
[115-6610]

UDC 669.018.472:620.187:539.382

INFLUENCE OF DEFORMATION ON THE PROPERTIES AND FINE STRUCTURE OF INVAR

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 1, 1980 pp 39-40

GAVRILYUK, S. I. and ZAKHAROV, A. E., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] Invars are typified by an anomalously low temperature coefficient of linear expansion. The value of this coefficient depends to a considerable extent on the plastic deformation and heat treatment of the alloy. The authors determine the influence of deformation before heat treatment on the magnetic, mechanical and physical properties and on the fine structure of Invar that contains 35.7% nickel, 0.05% sulfur, 0.010% carbon and 0.20% manganese. Deformation to 30% and 50% before standard heat treatment changes the coefficient of linear expansion, coercive force, hardness and fine structure of the alloy. With increasing deformation, hardness increases from HV 121 to HV 198. After standard heat treatment the hardness reaches the initial value for specimens deformed by 30 and 40%, and exceeds the initial value, reaching HV 140 for specimens deformed by 10%. The coefficient of expansion decreases with increasing degree of reduction, and beginning at a deformation of 30% it remains constant at $0.52 \cdot 10^{-6}$ deg^{-1}. After heat treatment, the coefficient of expansion for specimens deformed by 10% drops to $0.6 \cdot 10^{-6}$ deg^{-1}, and increases by about 20% compared with this figure for specimens deformed by 30% or more. The coercive force increases with deformation, reaching 340 A/m at a deformation of 50%. Heat treatment of specimens deformed by 30 and 50% reduces the coercive force to the value for the undeformed alloy. However, in the case of 10% deformation, heat treatment leaves the coercive force 60% higher than for the undeformed metal. Deformation reduces the region of coherent scattering and increases microdistortions. Heat treatment of the deformed specimens has little influence on the size of the region of coherent scattering, but considerably reduces microdistrotions. Figures 1; references 5: all Russian.
[115-6610]

UDC 533.92:535.35

ON THE FAILURE OF METALS DUE TO THE EFFECTS OF LASER RADIATION AND SHOCK-COMPRESSION PLASMA

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan-Feb 80 pp 44-49 manuscript received 10 Jan 78

SULTANOV, M. A., and OLEYNIKOV, V. P., Dushanbe

[Abstract] A controlled impulse generator on glass with added neodymium was used with a laser at an initial velocity of as much as 10 joules lasting about 10^{-3} seconds and a dispersion of $5\cdot10^{-3}$ rads. Metal destruction was observed visually and by photography using 35-, 75- and 150-mm lenses. Results showed that as the focus of the laser lens was moved away from the metal surface destruction decreased more slowly than when the focal plane of the lens was changed; the shape of the crater formed varied from cylindrical to conical, depending on the location of the focal point. A great number of separate microbeams were noted in the laser plasma of products of destruction. Specific heat physics properties of the metals tested are described. The basic function in breaking down the metals was attributed to the heat effect, with an explosive type of mechanism coming into action near the end of the radiation impulse. Figures 4; references 12: 11 Russian, 1 English.
[95-12131]

UDC 546.823.171

THE FORMATION OF CARBONITRIDE PHASES OF TITANIUM IN HIGH-TEMPERATURE NITROGEN STREAMS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, 1980 pp 62-66 manuscript received 21 Apr 79

ZALITE, I. V., PALCHEVSKIS, E. A., GRABIS, YA. P. and MILLER, T. N., Riga

[Abstract] Thermodynamic analysis was conducted of Ti-N-C-H and Ti-O-N-C-H systems and parameters calculated using the minimization of potential method in a temperature range of 1000-5000° K. Results showed that at atmospheric pressure the temperature range of 1800-2700° K was suitable for forming solid solutions with a balance of TiN and TiC, with the carbonitride composition being dependent on N:Ti and C:Ti ratios. With increased pressure the temperature of initial condensation also increased, and the temperature interval for carbonitride formation shifted to 2000-3100° K. Carbonitride formed by a chemical plasma method was found to be much more active than macrodispersion carbonitride. Figures 6; references 10: 6 Russian, 3 English, 1 German.
[95-12131]

UDC 535.337+539.26+534.222.2

FINE STRUCTURAL CHANGES OF CERTAIN NONMETALLIC MATERIALS UNDER THE EFFECTS OF WEAK SHOCK WAVES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, 1980
pp 119-123 manuscript received 2 Feb 1979

ARTAMONOV, A. A., ARTAMONOVA, L..N. and GRISHINA, L. D., Volzhskiy

[Abstract] Poly- and monocrystalline samples were studied before and after weak shock waves by X-rays and spectroscopy. Materials tested included sodium nitrate, naphthaline, powder and calcite, and the shock waves were caused by a copper wire explosive for polycrystals and an aluminum foil explosive with monocrystals, with energy ranging from 0.4-1.2 kilojoule. Variations in the strength of the shock wave had no apparent effect on the type II tension lines, but energy and displacement were directly related. A second series of X-rays showed a relaxation of tension and return to the original crystalline structures. The heat produced in the explosions also led to annealing of defects, particularly in substances with low melting points. The number of dislocation phases grew and chemical decomposition increased with the strength of the shock waves. Figures 3; references 12: all Russian.
[95-12131]

UDC 539.16.04.669.017

ON THE EFFECT OF THE PHYSICOCHEMICAL PROPERTIES OF METALS ON THEIR DESTRUCTION DURING LASER RADIATION PROCESSING

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, 1980
pp 124-127 manuscript received 19 Aug 77

VERKHOTUROV, A. D., ROSHCHINA, A. I., and DYATEL, V. P., Kiev

[Abstract] Laser processing was conducted in an air and argon mixture at 4--32 joules, with a 12 x 240 mm glass rod activated with neodymium as the working body. Focal length of the lens was from 50 to 70 mm, and beam density was varied from 10^6 to 10^8 watts/cm^2. Results showed a distinction in material removal and depth of penetration between intensities 10^7 watts/cm^2, and 10^7 watts/cm^2. In the first range a constant increase of material being removed was noted as the laser intensity grew. Of the metals tested, vanadium, niobium and tantalum were found to have increased heat conductivity as temperature increased, bringing deeper melting and significant deposits of erosion products on the metal surface. A second group, including hafnium, chromium, molybdenum and tungsten,

had deeper penetration and material loss as the radiation intensity was increased. The third group included titanium and zirconium, which had the lowest temperature parameters. Figures 2; references 4: all Russian. [95-12131]

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